MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

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Annual Report

For the Fiscal Year Ending June 30, 1945

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION—1944-45

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

The Effect of Public Regulation of Milk Marketing Upon the Organization of the Milksheds of Massachusetts Markets. (Alfred A. Brown, Elaine P. Miller, and Judith E. Rosenthal.) The collection, editing and tabulation of a series of price receipts and sales data for the ten years since milk control began is nearing completion. Efforts have been concentrated on the milksheds and markets in the principal secondary areas of Springfield, Worcester, Lowell-Lawrence, Fall River, and New Bedford.

In addition to contributing some light on the manner in which prices finally develop under public control, the study will provide a reasonably authentic series of data upon which the industry can build in coming years. Study has indicated the shortcomings and inadequacy of existing price records, and current work is directed towards overcoming that deficiency. Although this phase of the work may appear secondary to the major premise, it is important in a program of public pricing. And since milk control appears to be a permanent part of dairy marketing in Massachusetts the contribution of an accurate historical price series appears to be well worth while.

Transportation Requirements of Rural Communities in Massachusetts. (Alfred A. Brown and Elaine P. Miller.) The second part of this study was completed during the past year. The results of the analysis of milk trucking operations have been put to use in the principal dairy areas of the State. Daily truck mileage involved in moving milk from farms to plants had been 23,897. Following the study and conference with the industry this was reduced to 21,458 with a net saving of slightly over 10 percent.

A Study of Farm Real Estate Taxation, Methods of Taxation Reform, and the Effect of Such Measures on Farm Income. (Elaine P. Miller, Alfred A. Brown, and Judith E. Rosenthal.) The transcription of tax and assessment records on farms in the "Sampling Study" and on a selected group of dairy farms has been under way. About two-thirds of the records are in. Preliminary analyses have been made only for dairy farms and an extremely wide range exists between towns in valuations of livestock; cows from $40 to $125, chickens from 50 cents to $1.25, and horses from $25 to $200.

Other indications are that real estate will show much variation in assessment; that there will be little uniformity between real estate taxes paid and personal property taxes paid; that there will be little if any relationship in 1944 between size of farm (in acres) and amount of tax paid.

Development of Statistical Data as Controls to Livestock Production Program. (Alfred A. Brown, Elaine P. Miller, and Judith E. Rosenthal.) All three phases of field work in connection with this study have received much attention. The checking of maps, identification of farm locations, and collection of pertinent data on them have been completed for five counties. Classification of data has been advanced to the point necessary to permit selection of dairy farms.

For the dairy farms picked up in the identification detail, data on livestock numbers have also been secured from AAA milk subsidy records.

In the third sample under consideration, that used by the New England Crop Reporting Service, livestock numbers have been transcribed and tabulated.

Incomplete coverage of the major phase of the work precludes testing of the several samples. Comparison between the major sample and census population on a county or regional (three Valley counties) basis indicates an inaccurate selection. The random sample, selected on a square-inch-grid basis, is overweighted with small herds.

Loan Performance on Low Income Farms in Massachusetts. (C. R. Creek.) Standard rehabilitation loans which were made by the Farm Security Administration from 1936 through 1943 on 89 cash-crop farms in the three Connecticut Valley counties of western Massachusetts had been repaid in full by 66 farmers by June 1945. Of the remaining cases, 13 were classified as active borrowers who had received loans within the past two years, 5 were collection cases on old loans, and 5 had defaulted on their loans after making some repayments. Payments on these loans were made in large amounts from the sale of onions, potatoes and tobacco. Three years of good yields and high prices for crops enabled these farmers to pay off current and delinquent loans.

Standard loans which were made on 95 livestock and livestock–crop farms during this period were repaid by 53 borrowers by June 1945. Of the remaining cases, 25 were classed as active borrowers, 11 were collection cases, and 6 had defaulted on their loans after making some repayments. These loans were generally set up on a longer schedule of payments than the crop loans and payments were usually made each month from sales of poultry and dairy products. Payments from sales of crops were made by 74 borrowers to repay loans from 1936 to 1945. Sales of livestock and livestock products were the source of repayments on 21 farms. Auctions of livestock and equipment were necessary to close 14 loans, and income from work in industry was used to complete payments on 10 loans. On 62 percent of the farms, loans were repaid from crops; on 18 percent, from livestock enterprises; and on 20 percent, from sales of capital assets and industrial employment.

One or more standard rehabilitation loans had been made between 1936 and 1943 to 184 borrowers and by June 1945 loans were repaid in full on 119 farms or 65 percent; 38 loans or 21 percent were classified as active; and 27 loans or 14 percent were collection and defaulted cases. New loans were made in 1945 to seven borrowers, but not all of the active borrowers received supplementary loans in 1945.

Clearing and Improving Land on Massachusetts Farms. (C. R. Creek and J. F. Hauck.) Practically every farm in Massachusetts contains a few acres of once productive land that has reverted to timber, brush, shrubs, or weeds. Also many farms are divided into small fields of one to five acres by stone walls which were built many decades in the past. Other fields contain boulders and stones which prohibit the use of modern labor-saving machinery.

Within the past five years heavy machinery such as bulldozers, gas shovels, brush-breaker plows, and bog harrows have been used to clear land of trees, stumps, brush, and boulders, remove stone walls, dig drainage ditches, construct erosion controls, and remove old apple and peach trees from orchards. Land has been cleared in present farming units for pasture, poultry range, orchards, cranberry bogs, vegetable crops, potatoes, and field crops. In a few cases the acreage which has been cleared and improved was greatly in excess of the original cleared acreage, but in most cases from 5 to 20 acres of land have been cleared to increase the size of the original farm.

Costs of clearing land with heavy machinery varied greatly depending upon the type and density of timber, stump, or brush cover, the type of soil, the size and adaptability of equipment used, the skill of the operator, and the purpose for which the land was cleared. Records on costs and methods show that stumpland has been cleared ready to plow for as little as $65 per acre and as much as $180 Brush and trees have been cleared for $75 to $140 per acre and boulders removed for $60 to $150 per acre. Stone walls were removed by burying or hauling away for $6 and $9 per rod depending upon size of the wall and methods used. Apple trees were removed from orchards for 25 to 45 cents per tree and usually the value of cordwood cut more than paid for the cost of removal and cutting. Some drainage work has been done on individual farms but much of this land improvement work will be done after Soil Conservation Districts are formed.

Some examples have been noted of land clearing which could not be justified on the economic returns from the land. Where a good type of soil is available in the farm unit for the purpose desired, clearing with modern machinery may be profitable in a period of high prices for farm products. Larger acreages can be brought into production more rapidly by clearing with machinery to take advantage of these higher prices.

Organization and Management of Poultry Farms in Massachusetts. (C. R. Creek.) Poultry farming was less profitable in 1944 than in 1943 according to the summary of Poultry Account Records, chiefly because of lower prices received for eggs and higher prices paid for feed. For the records summarized, net farm income averaged $2350 per farm in 1944, $3660 per farm in 1943, and $2388 in 1942. Labor income per hen was $2.13, $4.20, and $2.85 for an average flock of 863,768, and 691 laying hens per farm. Egg production was 210 eggs per hen in 1944, 196 in 1943, and 206 in 1942 and the average price for all eggs sold was 47, 55, and 42 cents per dozen.

In 1944 the net farm income was $4604 per farm for the one-third highest income farms, which were chiefly breeder type farms, in contrast to $302 per farm for the lowest one-third, which were wholesale egg type farms.The size of laying flock was 1280 and 480 hens on these two groups of farms, while total size of the farm business was 690 and 250 productive man work units. Egg production was 216 and 189 eggs per hen and the average price received was 49.7 and 43.5 cents per dozen. The cost of feed per dozen eggs produced was 23.3 cents on the profitable farms and 29.7 cents on the low income farms. The margin of price received for eggs over cost of feed was 26.4 and 13.8 cents per dozen. It required 83 eggs at prices received to purchase 100 pounds of grain on the higher income farms and 97 eggs on the lower income group. A greater quantity of grain was fed per laying hen on the low income farms than on the more profitable farms and a higher price was paid per hundredweight. All of these factors of size, rate of production, prices received, feeding efficiency, and type of business were jointly responsible for the wide variation in returns from the farm business in these two groups.

A comparison of 15 identical poultry farm accounts for 1942, 1943, and 1944 showed that size of flock increased 16 percent from 819 to 953 hens. Egg production dropped 5 percent in 1943 to 200 eggs per hen but the price received was 56 cents per dozen which was 30 percent greater than in 1942. Feed cost per dozen eggs was 30 percent greater in the latter two years also, while the price received for eggs in 1944 was only 11 percent more than in 1942. The egg–feed ratio was most favorable in 1943 when 5.5 dozens of eggs were required to purchase 100 pounds of mash and scratch grain. The cost of hired labor on these farms increased 56 percent in these three years from $60 to $94 per month. Total labor cost, which included the value of the operator's time and family labor as

well as hired labor, increased only 38 percent while the efficiency of labor increased 18 percent as measured by man work units per man. The proportion of eggs sold as hatching eggs was greatest in 1943 at 38 percent of all sales, compared to 26 percent in the other years. Retail egg sales remained uniform in quantity during these years but the proportion of wholesale eggs was lower in 1943. Net farm income was $2890, $4260, and $2940 per farm for these three years. Labor income was $2370, $3715, and $2355, and there was an increase in investment from 1942 to 1944 of $1300 per farm. Farm income was $3.53, $4.74, and $3.08 per hen on these farms.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.)

Brown Root Rot of Tobacco. The object of this project was to determine the effect of the preceding crop on the yield and quality of tobacco. The various preceding crops were planted at three different times. All of the first seeding and some of the second matured; but none of the late seeding. All were plowed under during the following spring when they had been quite completely dehydrated by alternate freezing and thawing. The tobacco crop following the more mature of the preceding crops was not so good as that following the less mature plants. Mature plants contain more lignin and compounds not readily decomposed by microorganisms. Of the many crops grown preceding tobacco, tobacco, sunflowers, Jerusalem artichokes, and potatoes stand out most favorably; while sorghum, sudan grass, and corn are frequently exceedingly unfavorable to the tobacco crop. It is worthy of mention that the more favorable crops to precede tobacco are members of the Compositae and Solanaceae families, while all of the unfavorable ones belong to the Gramineae and Leguminosae families.

Black Root Rot of Tobacco. (C. V. Knightlinger.) In work to improve Havana Seed tobacco for use in the Connecticut Valley, new strains are being produced to effect improvements over Havana Seed 211 and other strains produced thus far. Some of the new strains are capable of producing high yields of tobacco of good type and quality in soils infested with the organism that causes black root rot as well as in soils relatively free from this organism. According to experimental results obtained from small plot tests, some of the new strains seem to possess improvements over Havana Seed 211 in type, quality, and habits of growth. The strains are being tested commercially, and some of them seem to be very promising.

Brown Root Rot of Tobacco. (C. V. Kightlinger.) Brown root rot ordinarily develops on tobacco that is grown immediately following certain other farm crops. Frequently, however, the disease fails to develop under these conditions in the Connecticut Valley. The cause of the disease and the reasons why at times it fails to develop under seemingly favorable conditions are not well known. The purpose of this project is threefold: first, to ascertain the effect on the development of brown root rot of tobacco of the rate at which fertilizer is applied to the preceding crop; second, to ascertain whether brown root rot will develop on tobacco grown continuously when less than the ordinary amounts of fertilizer are used; and third, to study the effects that conditions of low fertility may have on the root ailments of certain farm crops other than tobacco.

Work on the project is still in the preliminary stage of preparing the soil for fuller study of these objectives.

Disinfection of Tobacco Seedbeds. (C. V. Kightlinger.) Fall and spring steaming, chloropicrin, fall treatment with double strength formaldehyde, and spring treatments with single and double concentrations of formaldehyde were tested as soil disinfectants in tobacco seedbeds in 1944. The results were similar to those obtained in previous years.

Fall and spring steaming and chloropicrin were highly effective in the control of weeds. Fall and spring treatments with double strength formaldehyde were somewhat more effective than the spring treatment with single strength formaldehyde, although none of the formaldehyde treatments gave satisfactory control of weeds.

No damping-off or bedrot occurred in the seedbeds during the season; therefore, the comparative effectiveness of the different treatments in preventing seedbed diseases of tobacco could not be determined.

The Absorption by Food Plants of Chemical Elements Important in Human Nutrition. (Walter S. Eisenmenger and Karol J. Kucinski.) Both the type of ion and the evolutional development of the plant seem to have a part in regulating the intake of the various ions into the plant. The elements proportionately more abundant in sea water than in land waters seem to be more easily introduced into the plant. The more highly developed flowering plants seem to take up elements applied to the soil less than do the less developed types. Under similar conditions less calcium is taken up than potassium, sodium, and magnesium when each is added separately at the rate of 250 p.p.m. Chlorides, bromides, and iodides can be increased by larger percentages in plants than can phosphorus and sulfur when the two last-mentioned elements are applied to soil as phosphates and sulfates. The halides are more abundant in sea water than in land waters.

The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly. (Walter S. Eisenmenger and Karol J. Kucinski.) When 250 p.p.m. of calcium, magnesium, potassium, or sodium were added singly to plots, the intake of each into plants was increased. When two of these cations were added at the same rate to a single plot, the intake of each was less than when either of the two was added singly.

Preliminary experiments with seedlings of soybeans in water solution indicate that the higher the copper content of the growing medium, the lower is the calcium content of the aerial portion of the plant. These results may not necessarily hold true under field conditions. In field tests 75 pounds of copper sulfate was applied per acre. Plants grown on these plots will be analyzed to determine the effect of copper on the intake of calcium within the plant.

Magnesium Requirement of Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) During the past growing season, 1944, no heavy rains fell from the time of planting to the time of harvest. This was conducive to conservation of magnesium of the soil. Only a few species of plants showed the effects of slight deficiency of the element in the soil. This was apparently true throughout the State as no reports were available from extension and research men, or from individuals who usually bring in samples of plants grown on soils deficient in magnesium.

The Ranunculus, Malvaceae, Ulmaceae, Geraniaceae, and Cruciferae showed the deficiency only to a slight degree. No plants usually ascribed to the higher orders gave evidence of the slightest deficiency of magnesium.

Not all plants show the usual symptom of chlorosis. Among these plants are some of the purslanes and a few of the roses — *Portulaca oleracea*, *Rubus villosis*, *Potentilla canadensis*; and the common strawberry shows only an exceedingly

limited degree of chlorosis when magnesium is not sufficient for normal growth. The development from apocarpy to syncarpy marks an apparent diminution in need for the magnesium ion.

Long-Time Field Fertility Tests. (Walter S. Eisenmenger and Karol J. Kucinski.) Fifty-five to sixty years ago a series of soil test plots was established to study the effects on the soil and crops of a long-time fertilizer program. Various types of crops have been grown on these plots with the original plan of fertilization being followed each year. For the last three years the crop has been hay. Plots which receive a complete fertilizer and lime are outstandingly superior to all other plots. Check plots which have not received any kind of fertilizer since the inauguration of the tests show complete crop failure, with "haircap" moss coming in during the second season after seeding. In preliminary tests, rabbits fed grass grown on the limed plots showed growth curves superior to those of rabbits fed grass grown on the unlimed plots.

Young Sunflower Plants
The large leaves shade the ground preventing the growth of weeds.

Sunflowers and their Possibilities. (Karol J. Kucinski and Walter S. Eisenmenger.) Results of tests for several years show that sunflowers will grow abundantly in this region, producing good yields on any land which will grow corn. Sunflowers are hardy to light frost, and can be planted when it is safe to plant field corn. The plants are much more resistant to frost when they first come up than at the four or six leaf stage. Field trials have shown that the best spacing is one seed every 18 inches in 36-inch rows for the tall varieties like the Mammoth Russian. For shorter varieties like the Mennonite or Sunrise, 12 inches between plants and 36 inches between rows is recommended. Last year's trials indicate that the shorter-growing Canadian varieties (Sunrise and Mennonite), although yielding about 500 pounds less seed per acre, were superior to tall-growing varieties like Mammoth Russian in ability to withstand wind storms. The labor involved in taking care of sunflowers during the growing season is very little, since the plant starts to grow rapidly and soon shades the ground completely, killing any weeds that may survive the one or two early

hoeings. Because of its thick vegetative cover the sunflower plant serves admirably in ridding infested areas of obnoxious weeds.

Soil Conservation Research Projects. (Karol J. Kucinski and Walter S. Eisenmenger.)

Physical and Chemical Properties of Wind-Blown Soils. For several years laboratory tests and field observations have been made to determine why certain soils are subject to wind erosion while others are not. A wind tunnel has been used to supplement field observations.

Because of the unusually small amount of snow cover last winter, 1943-44, dust storms were very severe in the Connecticut River Valley. It was observed at several localities that wind erosion would start as soon as six hours after rainfall. In such cases the soil that was moved by the wind was the very thin top layer and usually contained less than 1 percent moisture, while the immediate sublayer contained 10 to 20 percent moisture. The application of such compounds as urea and lithium carbonate to soils greatly decreased their wind erodibility.

Use of Snow Fencing in Controlling Wind Erosion. One of the problems of Connecticut Valley farmers is the protection of soils and their crops from wind damage. The northwesterly winds which occur during early spring result in considerable losses to soil, seed, fertilizer, and young crops. Farmers have often noticed that certain local areas or spots are much more subject to blowing than the remainder of the field. This may arise from various conditions or a combination of conditions such as the location of buildings, slope of the land, direction of rows, difference in soil texture or drainage, etc. These "blowouts" usually appear sporadically in different years and under certain weather conditions. With the present emphasis on farm production, the farmer does not want to abandon these areas, yet the damage to his seed and young crops such as onions and asparagus may be considerable. To control these local "blowout" spots temporarily until the crop has established itself, some form of windbreak may be used. Trials are being made at the station to see whether so-called highway snow fencing will prove satisfactory for the purpose.

Results from these preliminary studies show that the anchorage of such fencing need not be so complicated as when it is used for prevention of snow drifting of highways. Old iron pipes or wooden stakes 4½ to 5 feet long driven 18 inches into the ground and spaced a rod apart held up the 4-foot-high lath fencing throughout the entire season. If the fencing is placed on the windward edge of the "blowout" at right angles to the prevailing winds and the crop rows are placed parallel to the fencing, very little loss of area or inconvenience in operation will be experienced. Generally one fence row will be sufficient to control "blowouts" of the size commonly found in this section. The cost of snow fencing is about 15 cents a running foot at present, but would be considerably less under normal conditions. This seemingly high initial cost should be prorated with respect to the longevity of the fence.

Erosion Problems Arising from Changes in Land Use. The increase of potato growing in certain localities in Massachusetts has resulted in soil erosion problems. Some operators are already experiencing a decrease in potato yield and have called on the Soil Conservation Service for aid in formulating plans for the protection of their fields. Laboratory tests show that there is an abnormal decrease of organic matter on some of these soils. It was found on several farms in western Massachusetts that the organic matter decrease in six years ranged from 14 to 31 percent with most of the decrease taking place in the first 2 or 3 years. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover-cropping, terracing, and contour farming of their hillsides.

Potato Seed Treatments. (C. V. Kightlinger and H. M. Yegian.) Experimental work begun in 1943 was continued in 1944, to ascertain further the comparative tolerance of varieties of potatoes grown commonly in Massachusetts to commonly used disinfecting seed treatments, and also the effectiveness of these seed treatments in controlling rhizoctoniose and scab. The varieties grown were Chippewa, Katahdin, Sebago, Earlaine, Irish Cobbler, and Green Mountain. The seed treatments used were mercuric chloride plus acid, yellow oxide of mercury, Semesan Bel, Sanoseed, Wettable Spergon, Thiosan, and Fermate. At the time of treatment, the seed potatoes were sprouted only slightly.

The inorganic treatments caused little injury to Irish Cobbler and Green Mountain tubers; moderate injury to Katahdin, Sebago, and Earlaine; and rather severe injury to Chippewa. These treatments caused reduction in stands of potatoes in the field, ranging from slight in the case of Irish Cobbler and Green Mountain to rather heavy in the case of Katahdin, Earlaine, and Sebago and heavy in case of Chippewa.

The organic seed treatments had no noticeable injurious effects on the tubers of any of the varieties before planting; but Semesan Bel, Sanoseed, and Thiosan had some detrimental effects on the stands of the Katahdin and Earlaine varieties and worse effect on the stand of the Chippewa, in the field.

None of the seed treatments seemed to increase the vigor of the plants. Careful examination of growing plants and later inspection of mature tubers after digging showed no consistent difference in the amounts of rhizoctoniose that developed from the use of any of the seed, treated or untreated. No scab developed by which to judge the effectiveness of the seed treatments as control measures for this disease.

On the basis of experimental results obtained from two years of testing, it seems that disinfecting seed treatments are of doubtful value as control measures for rhizoctoniose of potatoes at least. Rather heavy reduction in yields of potatoes of the newer varieties occurred, which it seems reasonable to attribute to the poor stands caused by the detrimental effects of some of the treatments on the seed tubers. On the basis of these facts, it seems doubtful whether disinfecting seed treatments are advisable for potatoes, especially for the newer varieties used in these tests.

Potato Variety Trials. (Karol J. Kucinski, Ralph W. Donaldson, Walter S Eisenmenger.) Because of the favorable growing season last year, all of the potato varieties tested did well, with yields per acre ranging from 510 bushels for Sebago to 347 bushels for Russet Rural.

Based on yields of marketable size, the ranking of potato varieties in the Experiment Station plots during the season of 1944 was Sebago, Pontiac, Sequoia, Chippewa, Green Mountain, Warba, Mohawk, Katahdin, Houma, Irish Cobbler, and Russet Rural.

Corn Improvement Program. (Hrant M. Yegian.) Fifty-five single crosses were made in the early-maturing group, involving all possible combinations of eleven inbred strains. Thirty-six double crosses were also made from the more promising of the previous year's ninety-one single crosses. Ninety-two varieties, mostly hybrids, were tested for their general adaptability and yield. The results were published in mimeographed form with the cooperation of the Extension Service, and are available upon request.

Onion Breeding. (Hrant M. Yegian.) Lots of 100 seeds from crosses between *Allium fistulosium* and *A. cepa* were soaked at room temperature in 0.1 percent colchicine solution from ½ to 120 hours to induce tetraploids. The majority of the seeds soaked from 3 to 5 days had thickened cotyledons and primary roots

at the seedling stage indicating chromosomal aberrations, but the leaves and the subsequent adventitious roots produced were normal. No tetraploids were observed in mature plants.

Over 50 percent of the bulbs from the first generation inbred strains having 2, 3, 4, 5, or 6 seed stalks per plants produced 3 or 4 seed stalks. The size of the bulbs, storage temperature, cultural practices, and weather conditions, as well as the genetic constitution of the strains, affect the keeping quality of bulbs, seed stalk development, and amount of seed produced.

Preliminary evidence tends to show that applications of borax at the rate of 30 to 50 pounds per acre did not prevent pink-root or fusarium bulb rot of growing onions, or increase the amount of seed produced by mother bulbs. However, it seems that borax may possibly have some subsequent beneficial effect on the keeping quality of stored onions At least in these trials the sets grown on borax-treated plots produced onions that kept better in storage, had brighter, more uniformly colored skin, and a more presentable appearance than did the onions grown from sets produced on untreated plots.

Seed from an improved strain was introduced last year to be tested by a commercial onion grower. The test is still in progress. However, the strain appears to be promising.

Experiments at Amherst with Hay and Pasture Seeding Mixtures. (W. G. Colby.) One of the principal objectives of these trials was to study the performance of different grass species and strains when seeded in combination with ladino clover alone and with ladino clover and alfalfa. It was hoped that strains of grass could be found which would be more satisfactory when grown with either one or both of these legumes than those now in general use; but even if superior strains were not found, it was thought that much valuable information might be secured which would be helpful in the development of a successful grass breeding program. Significant progress has been made in both directions. In these trials the following strains of orchard grass, meadow fescue, and perennial rye grass gave outstanding performance: orchard grass—S 26, S 37, and Finnish late hay; meadow fescue—Svalof Early and Otofte; perennial rye grass—O.A.C. No. 1 (now called Peron) A description of the experimental layout for this work has been given in a previous report (Mass. Agr. Expt. Sta. Bul. 388:14-15, 1942).

Breeding objectives have been formulated and breeding material has been isolated for further improving one already promising strain of orchard grass. It is probable that similar work will be attempted with certain strains of smooth brome grass.

As these different seeding mixtures have been observed from year to year (the plots are in their fifth harvest season), it has become increasingly evident that the performance of each mixture as well as each strain is influenced by many different factors. Among the most important of these are soil fertility relationships, including fertilizer practices; the nature of the original seeding mixture; the cultural management, including grazing management practices; and finally, the weather. In predicting the performance of a given hay or pasture strain of grass with ladino clover or alfalfa, the influence and relative importance of each of the above factors should be borne in mind.

Field Brome Grass (Bromus arvensis) for Poultry Ranges. (W. G. Colby.) Certain poultrymen have use for a grass which, when seeded in late summer or early fall, can be ranged the following spring on through to midsummer. Then, for the purposes of sanitation, they prefer to plow the land and reseed it for range the next season. Preliminary trials indicate that field brome grass can be successfully used in this way.

In early September 1944, two acres were seeded with field brome grass by a poultryman in Feeding Hills, Massachusetts. Results thus far in 1945 have been most promising. By spring this grass had made a dense matted growth which has since stood up well under heavy ranging conditions. A cover has been maintained even around range shelters and feeding stations. The herbage appears to be reasonably palatable.

The present season has been abnormally wet and this may account for some of the favorable results thus far. If this grass performs satisfactorily in a year with normal rainfall, poultrymen will have available another valuable grass for use on some of their ranges.

Field brome grass (*Bromus arvensis*) is a winter annual which must not be confused with smooth brome grass (*Bromus inermis*) which is a true perennial. Field brome grass has been used to a limited extent in Europe as a forage grass, but, as yet, its use in this country has been confined only to experimental trials. Seed was first secured by the Agronomy department in 1937 from a commercial seedsman in Germany and in 1938 from the Royal Danish Agricultural Society. Seed for these field trials on poultry ranges has been supplied by the Nursery Division of the U.S.D.A. Soil Conservation Service. Seed is not yet available commercially.

Breeding Work with Orchard Grass. (W. G. Colby.) Notwithstanding such desirable characteristics as tolerance to heat and drought, wide range of soil adaptability, good yielding ability, and resistance to lodging, orchard grass has never been popular for either hay or pasture. One reason has been its habit of early maturity. When used in hay mixtures, orchard grass matures from one to two weeks before any of the other common grasses or legumes in the mixture. If it is cut after maturity, it makes coarse, poor-quality hay. Its early maturity also makes it a poor pasture grass. Unless it is grazed promptly in the spring, it will form seed heads and become quite unpalatable.

Strains have been developed which mature from a week to ten days later than commercial strains and several have done well in the seeding mixture trials. However, most of these late maturing strains, including S 26, S 37, and S 143, are very susceptible to winter injury in the seedling stage and frequently suffer serious winter injury in established stands during severe winters.

One strain—Finnish late hay—has been found which is as hardy as commercial orchard grass, even in the seedling stage, yet matures from a week to ten days later. Seed of this strain was obtained in 1938 from a commercial seedsman in Finland. It has shown up well in both hay and pasture mixtures. It combines well with alfalfa and does reasonably well with ladino clover; at least it is much superior to all early-maturing hay strains of orchard grass. For the past two years seed has been increased so that small quantities are available for trial.

In order to further improve the performance of Finnish late hay orchard grass, a space-planted nursery was set out in 1944 using this seed. Late-maturing, winter-hardy plants, with desirable morphological characteristics were selected in 1945. These have been selfed and their progeny will be tested in 1946. It is expected to develop a new strain following the "strain building" procedure.

Trials with New Oat Varieties. (W. G. Colby.) For several years yield trials with new disease-resistant oat varieties have been carried on in cooperation with the U.S.D.A. Division of Cereal Crops. The following varieties have given good grain yields and have shown high resistance to leaf rust: Vicland, Tama, and Clinton. While oats are relatively unimportant as a grain crop in Massachusetts, they are grown quite widely for forage. Varieties resistant to leaf rust are, therefore, more valuable for Massachusetts conditions.

DEPARTMENT OF ANIMAL HUSBANDRY
Victor A. Rice in Charge

A Study of the Mineral Elements of Cow's Milk. (J. G. Archibald and C. H. Parsons.) The work with cobalt is still in progress. Extreme difficulties have been encountered in developing a method sufficiently refined to determine the very minute traces of this element present naturally in milk. All of the time devoted to the project this year has been spent in trying out different methods none of which have so far yielded reproducible results.

Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture. (J. G. Archibald and C. H. Parsons.) A good grade of silage has been produced this past year by mixing corn meal with various grasses at the rate of 150 pounds of meal per ton of grass. The silage kept very well, had a pleasing, mildly acid odor, and has been very palatable to cows. Considerable differences have been noted in the suitability of different grasses for ensilage. Reed's canary grass made only a fair quality of silage; bluegrass alone has not been at all satisfactory; but bluegrass mixed with other grasses has made good silage. In general, silage from a mixture of grasses or of grasses and legumes has been more satisfactory than silage made from single species.

Two technical articles based on this project have been accepted for publication during the past year. One, entitled "Seepage losses from a silo," appeared in the Journal of Dairy Science, Vol. 28, No. 4, April, 1945, pages 321-324. The other, entitled, "Studies in the chemistry of grass silage," will appear in the Journal of Agricultural Research presumably within the next three or four months. Conclusions of the first-mentioned article were that seepage losses in silage are not as serious as losses from other causes, and with good management can be reduced to a very insignificant figure. The most important conclusion in the second paper was that variations in silage quality due to the kind of crop ensiled were more significant than those due to the action of the preservative.

In addition to this work on the formal project, some time has been devoted to checking by observation and analysis the results obtained by a group of farmers who ensiled surplus potatoes furnished to them by the War Food Administration. In general a fair to good grade of silage was obtained, although a few failures have been noted.

Analyses of four lots of potato silage, one ensiled with alfalfa, two with oat hay, and one with sweet corn fodder, show that these silages were higher in protein, carbohydrate, and minerals than corn silage; lower in crude fat and fiber; and much lower in carotene. This last is what would be expected, for potato tubers do not contain carotene; and what little was found came from the relatively small amount of roughage mixed with the potatoes when they were chopped.

The quality of the silages made by mixing alfalfa or sweet corn fodder with the potatoes was excellent; when oat hay was used, the quality was only fair the rather high pH (4.9) indicating an unsatisfactory and insufficient fermentation. More serious than any failure to obtain good silage, however, has been the damage to cutter knives by stones mixed in with the potatoes during harvesting.

The Effect of Feeding Synthetic Thyroprotein to Milking Cows. (J. G. Archibald.) For a period of approximately seven months (April to November, 1944) this project was conducted in the Holstein herd of the Medfield State Hospital. Ten cows fed the hormone continuously for a period of twenty-one weeks, starting about midway of their lactation periods, showed a definite response in milk yield. In general this response took the form not of marked or sudden increase in milk yield, but of greater persistency in milk flow than was to be expected

from the production records of these cows in the first part of their lactations. At the end of the fortieth week of lactation, after twenty-one weeks of hormone feeding, average weekly production was 227 pounds per cow in comparison with an expected weekly production, based on previous performance, of 162 pounds per cow.

Four cows fed the hormone in alternate four-week periods for twenty-four weeks showed a definite response in the first two alternate periods, but it was unlike that of cows fed the hormone continuously in that it took the form of sharp increases in yield while the hormone was fed, followed by just as sharp decreases when it was discontinued. By the time the third and last alternate period of hormone feeding had been reached this sharp upward trend was no longer manifest and actual production dropped nearly to the level of expected production.

Of four cows fed the hormone in alternate two-week periods for twelve weeks, only one showed a marked response in milk yield.

Increases in milk production were usually accompanied by some loss in body weight, especially in the group that received this hormone continuously. These losses varied considerably in individual cows; over a period of five months they averaged approximately 50 pounds per cow in the continuous group, 30 pounds per cow in the 4-week group, and 20 pounds per cow in the 2-week group. No adjustment of the rations of these cows was made, but more recent work in the State College herd indicates that such losses can be made good by increasing the grain allowance in proportion to the increased milk yield.

There were no significant changes in the general condition, appearance, or behavior of these cows, neither was the composition of the milk significantly affected. There was some apparent disturbance of the reproductive function in the continuous group, these cows requiring on the average twice as many services for conception as they had required the previous year.

Because of labor conditions at the Medfield State Hospital, work on this project was transferred to the State College herd in the autumn of 1944. In the work in progress here, emphasis is being placed on the effect of the hormone on milk composition. Nineteen cows (seven Ayrshires, six Holsteins, and six Jerseys) were included in the trials conducted during the past winter. All that can be said at this time is that there have been rather marked differences in response to the hormone by the different breeds and also by different individuals within a breed. The project is being conducted in cooperation with Cerophyl Laboratories, Inc., of Kansas City, Missouri, which is furnishing the necessary thyroprotein.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Bacteriological Studies of Rural Water Supplies. (James E. Fuller.) This is a study of the growth and behavior of coliform bacteria at incubating temperatures up to 46° C., in the effort to evaluate the many atypical cultures encountered in testing rural water supplies. The cultures employed in the study were obtained from water samples sent to the laboratory for routine testing. Only typical *Escherichia coli* of sewage type was able to produce gas from lactose at 46° C. Most of the cultures studied proved, on this basis, to be soil-type coliform bacteria of questionable sanitary significance. Good results were obtained from the use of the methyl-red test at 44° C. This procedure seemed able to separate typical *E. coli* (positive at 44° C.) from atypical coliform cultures (positive at 37° C., but negative at 44° C.).

Relation of Chloramine-Resistant Bacteria to Milk Supplies. (James E. Fuller.) Previously published results (J. New England Water Works Assoc., 58: 89–100, 1944) showed a substantial increase in the number of positive presumptive tests (gas production in lactose broth) obtained in routine testing of the water after the chlorine-ammonia treatment was begun. These tests, however, could not be confirmed; that is, they were false presumptive tests. During the past year studies have been made to determine the cause of the false presumptive tests. Results follow:

1. Numbers of Gram-negative bacteria have been isolated that resemble coliform bacteria except for their failure to confirm, that is, to produce gas in lactose broth within 48 hours of incubation at 37° C. 2. By passing the cultures through successive tubes of lactose broth, the ability to produce gas within 48 hours was built up in a number of them. 3. By combining the cultures with one another, or with certain Gram-positive aerobic spore-forming cultures also isolated from the water, it was possible to obtain positive presumptive tests.

The conclusion was that the false presumptive tests obtained from the water supply are caused by coliform bacteria whose fermentative capacity had been so weakened by environment that they were unable alone to produce gas from lactose, but could do it when combined with other cultures. This study has been accepted for publication in the Journal of the New England Water Works Association for September, 1945.

The last phase of the study, now under way, is to investigate the possible effect of these bacteria on milk supplies. Some work has been done to determine their rate of multiplication in milk at several temperatures ranging from room temperature to that of normal refrigeration in an electric refrigerator. The production of acid and curd in milk under these conditions is also being investigated. Work on this phase of the problem has not progressed sufficiently to warrant any statement of results at this time.

Study of Septic Tank Efficiency. (James E. Fuller.) A preliminary statement has been made (Mass. Agr. Expt. Sta. Bul. 417, 1944, p. 17) explaining the origin of this project as a cooperative study with the State Board of Health Division of Engineering. After the Department of Bacteriology took over the project, a part of the tank installation was rebuilt, with the cooperation of the Department of Engineering of the Experiment Station, to eliminate certain faulty features of the original design.

It has not been possible to operate the project continuously, partly because the dormitory that supplies sewage to the tank has been occupied by pre-aviation cadets on a "here today and gone tomorrow" basis, and partly because the installation is not housed, with the result that deep snow and very cold weather necessitated suspension of operation in mid-winter of 1944-45. However, some results have been obtained.

The main object of the project was to study the effect of retention period on the efficiency of the tank in digesting the sewage. The tank has three compartments which receive sewage at rates that provide retention periods of 24 hours, 12 hours, and 8 hours respectively. The tank was put into operation in late August, 1944. Scum formed rapidly in the 12-hour and 8-hour compartments, and the outlets from both were plugged up solidly by early December with scum about 8 inches thick. The scum in the 24-hour compartment formed gradually and more normally and was about 2 inches thick when operation was suspended.

Bacteriological studies of the effluent showed that the coliform bacteria recovered at the beginning of operation were mostly typical *Escherichia coli*, while after about six weeks the type changed to *Citrobacter* which is a member of the coliform group but not so indicative of immediate fecal pollution as *E. coli*

This indicated that conditions within the tanks changed so as to favor growth of the *Citrobacter* rather than *E. coli*. The bacteriological results were about the same for all three compartments, as to both numbers and types of bacteria recovered.

Laboratory Service, July 1, 1944, to June 30, 1945. (James E. Fuller.)

Milk samples, bacteria counts	170
Ice cream samples, bacteria counts	79
Water samples, bacteriological tests	148
Total	397

DEPARTMENT OF BOTANY
A. Vincent Osmun in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.) *The Dutch Elm Disease Problem.* As of July 1, 1945, the Dutch elm disease caused by the fungus *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 54 trees in 19 municipalities in Massachusetts as follows:

	1941	1942	1943	1944	1945
Berkshire County					
Alford	1			2	
Egremont		3	2	3	
Great Barrington		1	1	6	2
Hancock					1
Lenox					2
Mount Washington				1	
Pittsfield				3	
Richmond					5
Sandisfield				1	
Sheffield		1		5	
Stockbridge				2	
West Stockbridge			1		
Williamstown					1
Hampden County					
Holyoke				2	
Longmeadow				1	
Southwick				2	
Springfield				2	
Westfield		1			
West Springfield				2	

In both Berkshire and Hampden Counties the spread of the disease is favored by the relatively unbroken continuity of elm population in valleys; and the prospect appears that in Hampden County, because of additional complications, the disease if unchecked may become more prevalent than in Berkshire County.

Certain conditions favor control, but not exclusion, of the disease in the eastern part of the State. In general, elms are more restricted there to plantings of ornamental and street trees. Such trees are likely to be better cared for by either private or public agencies. Also, in metropolitan areas, as contrasted with rural areas, elm in woodpiles favorable for breeding of bark beetles which carry the disease fungus, is not so common, and usually there is less movement of elm logs which might be infested with the carrier beetles. Additional factors affecting disease distribution throughout the State are yet to be evaluated.

In all parts of the State where diseased trees are found, surveys are made in the immediate vicinity and recommendations furnished to public and private agencies concerning desirable control measures. Although recommendations are made for particular conditions, they may be summarized as follows:

1. Keep elms as healthy as possible.
2. Spray elms to control elm leaf beetle and other insects.
3. In particular, if elms are cut, remove and burn the bark immediately. The bark beetles which carry the disease fungus breed in the bark of freshly cut elm.
4. Avoid piling elm wood in the open unless it is peeled. Don't transport elm wood with bark attached. Piled elm wood is more dangerous than standing dead trees.

Other methods of disease control are being explored, and, in cooperation with the Department of Entomology, means for control of carrier insects are under investigation.

Other Tree Problems. Fifty-four diseases of thirty species of trees including eight diseases of elm were identified from approximately 350 specimens and inquiries received during the year. The *Cephalosporium* wilt of elm was reported from two additional municipalities in which the disease has been found in Massachusetts. *Verticillium* sp. was isolated from several species of wood plants.

On September 14, 1944, a hurricane struck southeastern Massachusetts with devastating force. Along the coast the water did not invade and undermine property to the extent of the hurricane of September, 1938, but not until long after the excitement of the storm had passed, and in some instances not until the spring of 1945, was the complete effect of salt and wind on trees fully realized. In Barnstable, Plymouth, and Bristol counties thousands of trees were uprooted or shattered. Transportation and communication facilities were suspended or impaired for days or weeks while conditions were righted amid complications of shortages in labor and materials. A visit to the "graveyard" of almost any tree department is a revealing picture of trees lost. As for trees which withstood the storm, in the course of clearing operations they were sometimes left in hopelessly mutilated condition. Inadequate repair of injured trees always paves the way for future failure of damaged limbs. In limbs and crotches a hurricane rends the weak spots and creates additional ones. Viciously enough these in turn often become casualties of lesser storms. Events of recent years serve well to emphasize the need for better tree care and the detection of minor tree defects which may be corrected at limited expense. Neglect of current needed work is an expensive and indeed a deceiving false economy.

In many communities of Massachusetts on April 23 and 24, 1945, early morning frosts injured foliage of trees on which leaves had developed in response to warm spring weather. Damage varied from extensive on fruit trees to limited on some shade and ornamental trees.

Leaf diseases have been unusually prevalent on shade trees during June. The regularity with which rains occurred favored the development and dissemination of fungi involved. In some instances leaves damaged by frost, wind, and fungus infection had already fallen by July first, to a conspicuous extent.

During a severe electrical storm in Amherst on June 15, 1945, the following trees on the State College campus were struck: a large elm south of the tennis court near the cold storage plant, a large elm on Stockbridge Road west of French Hall, a sycamore northwest of Butterfield House, a linden east of North

College, and an ash west of Clark Hall. Damage varied from slight scorching of trunk to debarking of individual limbs and complete demolition of the ash.

In the early summer of 1945, two street trees, in each case located near catch basins into which water drains from near-by hillside streets, showed damage suggestive of chloride injury. During the winter the streets involved are well coated with salt to eliminate ice. Because of heavy snow and spring rains the water levels of basins were rather high this spring. Local conditions suggested that salt, which ordinarily might not be available to near-by trees, had reached their roots as a result of an unusual combination of circumstances.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L. Doran.) Work on the propagation of high-bush blueberry by softwood cuttings was continued in cooperation with John S. Bailey, and a second paper was published on the subject.* Cuttings rooted better if taken not later than 2 to 3 weeks before the first berries ripened. Their rooting was most improved and hastened by B-(indole-3)propionic acid, less by potassium indolebutyrate, and least by indolebutyric acid. Powder-dip treatments did not give so good results with blueberry cuttings as did solution-immersion treatments, but there were good results with Spergon–Hormodin No. 2.

Especial attention was given to the effects of combinations of certain fungicides with root-inducing substances, usually in the proportion of 1:1 by volume, for the treatment of cuttings.

In work with Lawrence Southwick it was found that length of life of unrooted softwood cuttings of McIntosh apple was consistently increased by Spergon–Hormodin No. 2 or No. 3, but was not prolonged by Hormodin No. 1 or No. 2 used alone. The life of such cuttings was also lengthened if, after solution-immersion treatment with indolebutyric acid, they were treated with Spergon alone. Mid-June cuttings of McIntosh rooted 33 percent after treatment with naphthaleneacetic acid followed by Spergon–Hormodin No. 2, not at all if treated with naphthaleneacetic acid alone.

Treatments of cuttings of rose with Spergon tended to retard rooting and subsequent growth, but Arasan or Fermate similarly applied gave good results. Thus, in a typical instance, rose cuttings rooted in the following percentages: check, 58; Hormodin No. 1, 77; Arasan–Hormodin No. 2, 93; indolebutyric acid 2 mg./gm. Fermate, 95. For rose cuttings, sand is to be preferred to sand–peat. It was found that the best type of rose cutting has 2 buds, one (upper) leaf with 3 leaflets or, if a 5-leaflet leaf, with the tip leaflet removed.

White pine cuttings, rooting not at all without treatment and relatively poorly with Hormodin No. 3 alone, rooted 64 percent after treatment with Fermate–Hormodin No. 3.

Cuttings of arbor-vitae rooted much better after treatment with indolebutyric acid 8 mg./gm. Arasan, Fermate, or Spergon than after similar treatment with indolebutyric acid in a carrier of talc. Indolebutyric acid 8 mg./gm. Fermate also gave excellent results with *Juniperus chinensis* L. var. *Sargenti* Henry. Cuttings of southern balsam fir rooted better if, after solution-immersion treatment with indolebutyric acid, they were given a powder-dip in Arasan or Spergon.

Probably because the root-inducing substance was too much diluted by the fungicide (there did not appear to be chemical injury), rooting of cuttings of the following species was more improved by treatment with Hormodin No. 3 than by treatments with mixtures of it and the fungicides named below: Colorado

*Doran, W. L. and Bailey, J. S. Propagating the high-bush blueberry by softwood cuttings. American Nurseryman 81:7:10. 1945. (Mass. Sta. Contrib. 554.)

fir and Sawara cypress with Arasan or Fermate; *Abies nephrolepis* Maxim. with Arasan, Fermate, or Spergon.

November cuttings of Norway spruce and Korean fir rooted in larger percentages in sand watered from above than in sand subirrigated; that is, watered only from below.

Rooting of November cuttings of Norway spruce was decidedly improved by treatment with manganous sulfate 0.5 or 1.0 percent solution for 22 hours. Rooting of cuttings of Chinese juniper was much more improved by treatment with potassium nitrate 500 mg./l., 18 hr., preceding treatment with Hormodin No. 3 than it was by Hormodin No. 3 used alone.

Rooting of cuttings of black spruce and of 3 varieties of Norway spruce was improved or hastened by treatments with monobasic potassium phosphate 0.25 or 0.5 percent solution, 21 hours; and in the two cases where comparisons were made, indolebutyric acid was less effective.

Cuttings of Colorado fir and *Juniperus squamata* Lamb. rooted less well if allowed to lose 10 percent of their fresh weight before treatment.

Beach plum cuttings rooted well in 4 weeks after solution-immersion treatment with indolebutyric acid even though they were taken as late in the season as the last of June. For these cuttings taken relatively late, powder-dip treatments were less effective.

November cuttings of a hemlock treated with Hormodin No. 3 rooted 92 percent if from the north side of the tree, 25 percent if from the south side. November cuttings of a Norway spruce treated with manganous sulfate (1.0 percent solution, 19 hr.) rooted 50 percent if from the north side of the tree, 8 percent if from the south. December cuttings of arbor-vitae finally rooted 100 percent in any case, but those from the south side of the tree required 50 to 75 percent more days for rooting. Out of 31 possible comparisons with white pine cuttings taken in March from 3 different trees, cuttings from the north side of the trees rooted best in 17 cases, those from the south side in 7 cases, and there were no differences in 7 others.

Treatments of November cuttings of arbor-vitae (with indolebutyric and indolepropionic acids) which were apparently injurious in sand–sphagnum peat were not injurious in sand–sedge peat. November cuttings of Norway spruce rooted better in sand–sedge peat than in sand–sphagnum peat.

Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) The effects of certain soil treatments on club-root of cabbage (caused by *Plasmodiophora brassicae* Wor.) were investigated. The disease was not prevented by ammonium sulfate (and lime), calcium cyanamide, or Fermate as used, but it was fairly well controlled by mercurous chloride 0.2 or 0.15 gm. per square foot without injury to growth of plants. Mercuric chloride similarly used retarded their growth. Sodium chloride used alone did not control club-root but 10.0 gm. per square foot appeared to be favorable to growth of plants and mercurous chloride gave rather better control when used with sodium chloride than when used without it. The percentages of infected plants were:

Soil Treatment	Percentage of Infected Plants
No treatment	95
Mercurous chloride 0.15 gram	33
Mercurous chloride 0.15 gram plus sodium chloride 10 grams	13
Mercurous chloride 0.2 gram	20
Mercurous chloride 0.2 gram plus sodium chloride 15 grams	0

Tomato seedlings emerged and grew more slowly if seeds treated with Arasan were planted in untreated soil than if untreated seeds were planted in soil which, immediately after seeding, received an application of formaldehyde, one teaspoonful per gallon of water. And, in untreated soil, tomato seedlings made more growth in their first three weeks if seeds had been treated with red cuprous oxide than if they had been treated with Arasan.

In soil heavily infested with damping-off fungi, principally species of Pythium, and having a relatively low moisture content at the time of seeding, there was usually less damping-off, and final stands of cabbage, tomato, pepper, lettuce, beet, and onion were usually much better if soil was not watered until 4 to 6 days after seeding, than if the soil was first watered immediately after seeding, as it commonly is. Similar postponement of the first watering after seeding also resulted in improved stands of Aubrietia, China aster, and zinnia.

Work done on the control of smut and pink root-rot of onion was with the cooperation of Thomas Sproston, Jr. A paper entitled, "Control of onion smut by fungicides applied to the soil" was presented at the Annual Meeting of the New England Division of the American Phytopathological Society. An abstract of this paper has been accepted for publication by Phytopathology. Onion smut, caused by *Urocystis cepulae* C. C. Frost, was well controlled by 58 pounds Fermate mixed with 1500 pounds of a 5-8-7 fertilizer per acre, applied immediately before seeding. Fertilizer used alone lessened the severity of smut but of course not enough. The percentage of seedlings which, in a typical instance, became infected with smut was 88 percent in a soil without treatment, 56 percent in this soil with fertilizer, and 1 percent in this soil with fertilizer to which Fermate had been added. Fermate so used was not injurious to growth of plants. There were comparable results when Arasan was similarly used. Smut was well controlled by Puratized N5-X and also by the nitrites of sodium and calcium, but Fermate used as above described gave better results. Urea and calcium cyanamide gave fair control but, as used, they caused some injury to onion seedlings.

Soil in which onions had grown poorly and in which they were known to have had pink root-rot, was variously treated before planting onion sets or sowing onion seeds in it. Numbers of onion seedlings which lived, as compared with numbers in untreated soil, were increased 80 percent by sodium nitrite, almost as much by Fermate. Fermate was ineffective, however, in preventing pink root-rot. But with pink root-rot severe on onions from sets in untreated soil (a species of Fusarium was isolated from diseased roots), the disease was at least partly controlled and early growth was markedly improved by copper sulfate 200 pounds or sodium nitrite 400 pounds per acre.

Tomato Leaf Mold Caused by the Fungus Cladosporium fulvum Cke. (E. F. Guba, Waltham.) Previous reports by the writer describe the discovery of resistance to all local strains of Cladosporium among certain primitive tomatoes received from the Division of Plant Exploration and Introduction, U. S. Department of Agriculture, and his progress in crossing these types with the Bay State variety. The Bay State tomato (Mass. Agr. Expt. Sta. Bul. 393) is now very susceptible to a variant strain of leaf mold.

The best approach to desirable types of greenhouse forcing tomatoes appeared among the progeny of successive generations of crosses of Bay State with a primitive type No. 129882 from Peru and No. 112215 from Ecuador.

A further series of crosses was made of selected lines of the above hybrids with Vetomold-121, Bay State, Waltham Forcing, and Marglobe. The crosses with No. 112215 are giving the best performance. The F_3 generation will be grown in several commercial greenhouses for trial in the fall growing season

(1945), and for further selection to pure line the tomato for resistance and high yielding type.

Laboratory prepared dusts containing 5 percent Thiosan, Fermate, Spergon, or Dithane (HE-175), with 95 percent talc are fungicidal to Cladosporium spores. Dusts containing 10 percent active chemical and 90 percent talc gave satisfactory control of spore germination when a water suspension of spores was applied to dusted slides. The Dithane dusts were injurious to tomato foliage. The use of the tolerant dusts would appear to meet the demand for a suitable fungicide for the control of tomato leaf mold in the greenhouse.

Causes and Control of Decay of Squash in Storage. (E. F. Guba, Waltham.) The growing season was unusually dry. Six plots of Blue Hubbard squash were grown, each of an area of 7,350 square feet and comprising 34 hills. Three plots were sprayed five times with Bordeaux 4-4-50 mixture combined with calcium arsenate 1 pound and spreader; three similar plots were not sprayed. The unsprayed out-yielded the sprayed plots, thus confirming the results of the previous year. The residue of the spray persisting on the squash in storage would appear to provide some protection against decay organisms, but storage up to November 1944 showed no significant or consistent contrast among the six harvested lots of squash. Loss from decay was negligible. Shrinkage was greater among the stored squash from the sprayed than from the unsprayed plots. These results, at least in a real dry season, would appear to discourage field treatment with homemade Bordeaux mixture as a disease preventive treatment. Other types of fungicides are suggested for trial.

Interrelation of Wettable Sulfur, Lead Arsenate and Lime in Apple Spraying. (E. F. Guba and E. V. Seeler, Jr., Waltham.) This project is intended to improve upon our knowledge of the apple spraying schedule, involving the substitution of materials to avoid injury, selection of the best types of sulfur to insure the greatest protection against disease, selection of the most efficient fungicide for scab eradication, the effect on the adherence of sulfur of adding lead arsenate and lime, etc. As in the past, detailed reports are compiled and submitted to cooperating leaders.

The year 1944 was an off season for chemical russet injury on Red Delicious and no results were obtained. The usual amount of weather russet injury occurred on Golden Delicious, and as usual the greatest percentage of russeted apples occurred on the unsprayed trees. The season was too dry for an evaluation of the protective action of various sulfur pastes used. The destruction of scab spores on the foliage was best accomplished with lime sulfur 32° Be 2 gallons, Everett Flotation Sulfur Paste 16 pounds, and Fermate 1½ pounds to 100 gallons of water. The results with Wettable Spergon 2 pounds, HE-175 (Dithane) 1½ pounds, and DN-111 1¼ pounds to 100 gallons of water were unsatisfactory.

Effect of Soil Temperature on Leaf Shape of Tobacco. (L. H. Jones.) The effect of soil temperature on the shape of leaves of Havana Seed tobacco has been found to occur in the absence of a mosaic virus. The apparatus provided two constant soil temperatures, a low at 70°F. and a high at 90°F. At the low temperature the leaves developed consistently as the normal ovate shape. At the high temperature the newer leaves appeared yellow spotted, light green in color, narrow, and very pointed, fitting the description of what is called frenching in tobacco. Inoculation of healthy plants with the leaf juice of these frenched leaves failed to result in the development of any symptoms of a mosaic virus, while comparable healthy plants did develop mosaic symptoms when inoculated with the juice of mosaic-affected leaves.

Changing the soil temperatures from the low to high and from the high to low altered the shape of the new leaves formed after the change of temperatures. Those plants which had been growing at the low of 70°F. with normal leaves soon produced frenched leaves at the tip when the soil temperature was raised to 90°F. On the other hand those plants which had been growing at 90°F. soil temperature and had produced frenched leaves at the tip reacted to the dropping of the soil temperature to 70°F. by sending out lateral shoots, the lower leaves of which were frenched but as the shoot grew the leaves developed with less frenching and were practically normal at the tip.

Toxic Effect on Plants by Wood Preservatives. (L. H. Jones.) Continuation of the work previously reported on creosote injury to plants showed that the injury was local. The fumes are evolved from creosote-treated lumber by the high temperature of the sun's rays and pass into the leaves of plants through the stomata. An exposed leaf on a vine or stem may be killed, but the creosote fumes are not transmitted by the vascular system to adjacent parts. However, if the injury is in the region of the growing point, further growth is stopped and the plant will die unless the nature of the plant allows the development of lateral shoots, one of which may become a leader.

No injury resulted from attempts to have creosote or its fumes absorbed through roots of plants in the soil. Seedlings of cabbage protected from creosote fumes by glass shells were uninjured although the creosote fumes were free to enter the soil and be absorbed by roots. One teaspoonful of creosote mixed with the volume of soil in a 3-inch pot failed to give injury even with a recorded soil temperature of 108°F. Creosoted tomato stakes with the creosote slightly above the soil line did no harm to plants, when young or at any time during the season.

Cabbage maggot protectors made of heavy paper impregnated with creosote did not injure cruciferous plants except when the stalks were soft and tender. Unhardened plants were liable to be burned by the fumes where the impregnated paper came in contact with the stalk. Injury also occurred when growers failed to remove translucent hoods before the sun's rays became strong enough to volatilize the gases of creosote in the paper, which were then confined under the hoods. Tests made with these protectors tacked to lath and placed close to radish rows resulted in injury to the radish plants. Even after the radish plant had four true leaves and was four inches high, injury resulted and the leaves were severely injured. Probably the closeness of the leaves did not allow good air drainage and the fumes collected about the leaves.

Lumber with the trade name of Asidbar, impregnated with resins from which the more volatile constituents had been removed, was injurious to seedlings of cabbage and tomato when the lumber was at a higher level than the seedlings. The injury was similar to creosote injury, resulting in a rolling upward and inward of the margins of the cotyledons and first leaves of cabbage and tomato. Death of the seedlings was frequent. Injury did not appear during cloudy weather but followed hot sunny days, indicating that some fumes are evolved by the influence of the sun's rays. Asidbar lumber buried in the soil in close proximity to seeds of tomato and cabbage gave no indication of a toxic effect. In fact the roots of the seedlings developed in contact with the wood, remained white and developed branches in contact with the wood. A recorded soil temperature of 96°F. on a hot day was not followed by any indication of injury from this lumber protected from the sun's rays by the soil covering.

Cuprinol, a copper naphthenate, when used as a wood-preservative paint did not injure plants. Before plants or seeds were used near the painted wood, a week was allowed to elapse in order that the volatile carriers of the preservative might evaporate.

Chlorine Injury to Plants. (M. A. McKenzie and L. H. Jones.) Following investigation of a tree trouble which proved to be of non-parasitic origin, the possible involvement of escaping gas from a nearby chlorinator led to an investigation of the effect of chlorine on woody plants. Available literature on chlorine in relation to plants concerns chiefly chlorine in water used on soil in which plants were growing. In conformity with common opinion, no injury was observed when potted plants were watered with a mixture of chlorine and water applied only to the soil. Injury[1] did occur, however, when an equal quantity of the same mixture was applied directly to the foliage.

Resistance to Fusarium dianthi. Prill. et Del., the cause of a serious carnation wilt disease. (E. F. Guba, Waltham.) The reaction of many standard varieties of carnations (*Dianthus caryophyllus* L.) to *F. dianthi* has been determined by artificial inoculation methods. Selected varieties showing a highly resistant reaction to the branch rot fungus will be selfed and crossed for a similar analysis of the progeny. The wilt-resisting seedlings will be carried to flowering in search of types meeting commercial standards.

Both Arasan (tetramethylthiuram disulfide) and Fermate (ferric dimethyldithiocarbamate) in mixtures of 10 percent with 90 percent talc gave good control of Fusarium wilt in the propagating sand when the basal end of artificially inoculated cuttings was treated with the chemical dust before the cuttings were planted. A mixture of either of these fungicides with hormone dust in the ratio of 10-90 respectively for a combined disease control and root inducing effect is indicated.

Considerable time was devoted to the preparation of a Station bulletin on the subject of carnation wilt diseases and their control.

Miscellaneous Studies. (E. F. Guba and E. V. Seeler, Jr., Waltham.)

Damping-Off Control with Seed-Borne Chemicals. As in previous years the various dry chemical seed treatments were tested for their control of damping-off of vegetable stands. The cold temperatures and abundant rainfall prevailing throughout the vegetable seed sowing season were ideal for these tests. The results will be compared with those of previous years and the preferred treatments arranged in a chart or guide for market gardeners.

DEPARTMENT OF CHEMISTRY

Walter S. Ritchie in Charge

Studies on the Quantitative Estimation of Hemicelluloses. (Emmett Bennett.) Hemicelluloses constitute one of the largest single group of substances in plant material, but because of the association with other compounds and the heterogeneity of the substances, their determination is one of the least satisfactory to make. After making other preliminary tests utilizing the charge on the hemicellulosic particle as a basis, it seems more advantageous to start with the holocellulosic material. Preliminary experiments indicate that sodium chlorite can be used effectively in preparing the holocellulosic fraction from non-woody plant tissue for the quantitative estimation of hemicelluloses. This procedure, while long, is simple, requires little attention, and eliminates other more tedious and lengthy operations. The resulting product is substantially free of lignin and contains the hemicelluloses. No statement concerning the actual quantitative estimation is warranted at this time.

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[1] Jones, L. H., and McKenzie, M. A. Chlorine gas injures trees. Arborist's News 9:89-90. 1944. (Mass. Agr. Expt. Sta. Contrib. 541).

The Chemical Investigations of Hemicelluloses. (Emmett Bennett.) Hemicelluloses were isolated from corncobs and rye straw by the alkali method. Hypochlorites and bromine were used in purifications. The purified substances were subjected to chemical treatment which would indicate some facts regarding their chemical nature. The results of these investigations seem to indicate the following:

(a) Xylose appears to be the chief sugar present in both preparations. A uronic acid, believed to be glucuronic acid, was also present in both samples. Glucose was present but galactose could not be detected.

(b) As indicated by acetylations, corncob hemicellulose has two free hydroxyl groups. The theoretical acetyl content of $C_9H_{12}O_6$ is 39.81 percent: the prepared product contained 39.73 percent. The theoretical and actual carbon content of the acetate are 49.98 and 49.50 percent respectively. These data indicate that the xylose units probably are linked through the 1, 4 positions and that the preparation was quite pure. Hemicellulose from rye straw does not acetylate satisfactorily.

(c) The "repeating units" appear to be of from 25 to 40 units in length, corresponding to an approximate molecular weight of from 3000-6000.

(d) Hydrolytic and polariscopic studies indicate that the xylose units in both hemicelluloses have a pyranose structure with a beta-type linkage between units.

(e) Alkali-lability numbers are about equal and are comparable to those of commercial samples of corn starch.

(f) Complete hydrolysis of both hemicelluloses could be obtained with 4 percent sulfuric acid in approximately four hours, whereas the usual time is about 15 hours. This shorter time of hydrolysis decreases the destruction of uronic acids.

The Investigation of Agricultural Waste Products.—1, The Chemical Investigation of Lignin. (Emmett Bennett.) The work on this project to date has been devoted to ascertaining the effect of large quantities of pure lignin upon the aerobic decomposition of plant materials of varying composition.

Pure lignin was added to finely ground samples of silage, timothy hay, corn stalks, and oat hay, thoroughly mixed, inoculated with a soil suspension, and allowed to incubate at about 32°C. for several months. The lignin contained 64.2 percent of carbon and 5.6 percent of hydrogen and was added in amounts equivalent to about 14 percent of the plant material. In order to increase the supply of nitrogen for microbial activity one gram of nitrogen in the form of ammonium carbonate was added to each 100 grams of organic material. Controls were used in each case. At definite intervals, representative samples were removed and analyzed for total nitrogen, ammoniacal nitrogen, solids, and pH.

Tentative results indicate that there was a greater loss of organic matter from the corn stalks and oat hay in the presence of added lignin: timothy hay and silage decomposed at about the same rate with or without lignin. In general, ammonification was retarded in the presence of lignin.

Although we have no data on the influence of the products of decomposition on the vigor of the plant, it would seem that added lignin does not materially alter the rate of the aerobic decomposition of plant material if sufficient nitrogen is available.

Factors Affecting the Vitamin Content of Milk and Milk Products. (Arthur D. Holmes.) Milk, which has been described as nature's most perfect food, is of especial importance to the residents of Massachusetts. From the farmers' viewpoint, it is one of the principal agricultural products of the State and it is highly

important to the consumer since it is a particularly valuable food which is consumed in such large amounts that a great deal is imported from other areas to supplement that produced in Massachusetts. Obviously many factors affect the vitamin content of milk, but recently attention has been largely centered upon the influence of the ration and the effect of sunshine on cow's milk and a study has been made of the vitamin content of goat's milk collected from numerous areas of the State.

The Ratio of Ascorbic, Nicotinic, and Pantothenic Acids, Riboflavin, and Thiamine in Late Summer Milk. (Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, Katherine Esselen, and Beula V. McKey.) The milk used in this study was produced by the college herd of Ayrshire, Guernsey, Holstein, Jersey, and Shorthorn cows in the late summer when the pasture grasses were fully mature, but before severe frosts had affected their quality. The pasture ration was supplemented with ground grains (14 percent) at the rate of one pound for each six pounds of milk the cows produced. Fifteen samples of milk, which represented 15 days' production, were assayed. The values obtained varied somewhat from day to day, but averaged ascorbic acid 18.4 mg., nicotinic acid 1.1 mg., pantothenic acid 3.66 mg., riboflavin 1.37 mg., and thiamine 0.44 mg. per liter. Judged by the dietary allowances recommended by the National Research Council, such milk would have to be fortified with ascorbic and nicotinic acids to meet the recommended allowance for infant feeding.

Effect of Sunshine upon the Ascorbic Acid and Riboflavin Content of Milk. (Arthur D. Holmes and Carleton P. Jones.) It has long been known that sunshine or strong light tends to destroy ascorbic acid and riboflavin. Accordingly, it appeared desirable to determine the extent to which sunshine might reduce the nutritive value of milk by destroying these vitamins. Similar studies had been reported from other laboratories, but unfortunately the authors did not measure the sunshine to which their samples of milk were exposed. Accordingly, milk produced by the college herd was exposed to the action of sunshine for two 30- or two 60-minute periods in ½ pint commercial milk bottles. The intensity of the sunshine was measured with a pyrheliometer equipped with an automatic recording device. The "sunshine" varied from a total of 4.8 gm. cal. per sq. cm. on a rainy day to 144.6 gm. cal. per sq. cm. on a bright day. The temperature of the milk varied from day to day depending upon the velocity of the wind, greenhouse effect of the milk bottles, and intensity of the sunshine. The destruction of reduced ascorbic acid was very rapid. Little, if any, was present after 30 minutes' exposure. The riboflavin disappeared more slowly. A 10 percent loss occurred during 60-minutes' exposure on a rainy day and 85 percent disappeared during exposure to bright sunshine for 120 minutes. These data show that milk allowed to stand for more than a short period on the consumer's doorstep exposed to strong light or sunshine, is likely to lose a large amount of its ascorbic acid and riboflavin.

The Vitamin Content of Commercial Winter Goat's Milk. (Arthur D. Holmes, Harry G. Lindquist, Carleton P. Jones, Anne W. Wertz, Katherine Esselen, Beula V. McKey, and Evelyn Fuller.) It has been estimated that the retail value of goat's milk produced in this country exceeds $100,000,000 annually. A large portion of the fluid milk is used for infants, for invalids, and for consumption in the home of the producer. However, a review of the literature revealed very little information on the vitamin content of goat's milk. Accordingly, 18 samples of raw goat's milk from various localities within 100 miles of Amherst were assayed. Data were collected concerning the breed of the goats, their age and stage of lactation, and their ration. The average values obtained were fat

4 percent, bacteria 1300 per cc., ascorbic acid 6.5 mg., nicotinic acid 2.96 mg., pantothenic acid, 3.38 mg., riboflavin 1.25 mg., and thiamine 0.47 mg. per liter. These results show that goat's milk is a very valuable source of the vitamins noted above.

The Variation in the Bacteria, Fat, Ascorbic Acid, and Riboflavin Content of Goat's Milk. (Arthur D. Holmes, Harry G. Lindquist, and Elliott K. Greenwood.) The present curtailed supply of milk and milk products in Massachusetts has stimulated the use of goat's milk instead of cow's milk, particularly in families of foreign birth or ancestry. Coincident with the increase in the number of goats and in the number of consumers of goat's milk, there has been an increasing demand for information regarding the nutritive value of goat's milk. Accordingly, 39 samples of goat's milk were obtained from various localities throughout the State. They were shipped to the laboratory carefully packed in ice and the temperature on arrival was 34°-40°F. Sixty percent of the samples represented a single milking of one animal, but the other samples were composites of milk from herds of 8, 19, 50, and 65 goats. Four breeds of goats were represented, French Alpine, Nubian, Saanen, and Toggenburg. Their ages varied from 1 to 12 years and the stage of lactation varied from 10 days to 36 months. None of the goats received any corn or grass silage. The majority were stall-fed, but 14 of the samples were from goats that also received various herbage varying from buds and twigs of bushes to good Ladino clover, timothy, and red top pasture. The bacteria count varied from 20 to 21,300 per cc. The average for 38 samples was 3,500 per cc. or practically only 1/3 that allowed for certified cow's milk. The fat content varied from 2.2 to 6.5 percent and averaged 4.3. The reduced ascorbic acid of milk from the stall-fed goats averaged 15.1 mg. and that from the goats which received some pasture averaged 20.0 mg. per liter. The riboflavin content of the milk from the stall-fed goats averaged 1.24 mg. per liter, which is identical with that obtained in a previous study. The average riboflavin content of the milk from goats which had access to pasture was 1.02 mg. per liter, which is in accord with another observation that the riboflavin content of cow's milk decreased from 1.43 mg. to 1.26 mg. per liter when a mixed herd of cows was changed from a ration of hay, silage, and grain to a pasture of young, rapidly growing green grass. Apparently the bacteria count, fat, ascorbic acid, and riboflavin content of goat's milk vary considerably with the source of the milk. These results also show that the goat's milk under consideration contained fewer bacteria and less riboflavin, but about the same amount of fat and ascorbic acid as cow's milk.

Influence of Calcium and Magnesium upon Composition of Boston Head Lettuce. (Arthur D. Holmes and Leo V. Crowley.) For many years lettuce has been classed as a protective food since it contains minerals and vitamins which are not present in adequate amounts in carbohydrate-rich and fat-rich foods. While meat and dairy products are relatively rich sources of minerals and vitamins, they are much more expensive and at the present time can be purchased in only limited amounts. Commercial and practical gardeners are of the opinion that frequently the quality and yield of lettuce can be enhanced by supplementing the usual lettuce fertilizers with lime or lime and magnesium. Accordingly, a study was undertaken to determine whether the mineral and vitamin content of lettuce may be significantly influenced by the use of these supplementary fertilizers which were applied at the rate of 150 pounds of magnesium sulfate per acre, 1,000 pounds of limestone per acre, and a combination of 150 pounds of magnesium sulfate and 1,000 pounds of limestone per acre. The use of magnesium sulfate as a supplementary fertilizer increased the magnesium content

of the lettuce but it also reduced the calcium, iron, and phosphorus content. The use of magnesium sulfate and lime or lime alone as a supplementary fertilizer tended to reduce the carotene, calcium, iron, and phosphorus content of the lettuce and caused a definite decrease in the magnesium content. The values obtained show lettuce to be a valuable source of carotene, riboflavin, calcium, iron, magnesium, and phosphorus and to be well deserving of its classification as a "protective food" for the human dietary.

CONTROL SERVICES

Philip H. Smith in Charge

The fertilizer, feed, seed and milk testing laws are administered as one service and the operations of each of these, with the exception of the milk testing law, are reported in annual bulletins issued for that purpose.

Under the milk testing law 6,407 pieces of Babcock glassware were tested for accuracy and 85 certificates of proficiency in testing were issued. In addition, all milk depots and milk laboratories in the State were visited at least once, as required by statute, in order to check apparatus and the general conduct of the work. In order to promote greater efficiency in checking on the accuracy of testing, the field men of the Milk Control Board have been deputized to conduct investigations This is authorized by law.

In addition to regular routine duties, Control Service has been called upon to the extent of time available to assist other departments of the College and Station in conducting work in connection with research problems not originating in the Control department itself. Such service has been rendered during the past year to the Departments of Pomology, Olericulture, Animal Husbandry, Veterinary Science, Agronomy, Poultry Husbandry, Dairy Industry, Waltham Field Station, Food Technology, and Research Chemistry.

Considerable time has been devoted to assays and analyses not directly connected with the requirements of the several acts but for which there appears to be need. Some of the work covered has been assays for riboflavin, carotene, choline, and trace mineral elements in feeds.

Control Service has also examined feeds and fertilizers submitted by citizens of the State and State Institutions. Where such work can be construed to be of general public value no charge is made.

The work of the Seed Laboratory continues to enlarge, not only on account of the temporary increase in War Gardens, but also because of a growing realization on the part of retail seed dealers that good seed is of prime importance if a good crop is to be expected. Each year retailers in growing numbers submit, prior to sale, the seed they expect to offer. During the year a new seed germination room has been installed which greatly facilitates the testing of the larger field and garden seeds.

THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.) *Hill Fireworm* (*Tlascala finitella*). There were plenty of these worms on the heavily vined Burrage bog at South Hanson in June, 1944 Cryolite, 50 pounds to the acre applied as a dust on June 28, gave excellent control of the pest.

Cranberry Spittle Insect (*Clastoptera saint-cyri*). This insect began to hatch on Cape Cod cranberry bogs as early as May 31, in 1944.

Armyworm (*Cirphis unipuncta*). This worm appeared in numbers on many cranberry bogs from which the winter water was let off as early as May 20 in the spring of 1945.

New Insecticides. During the 1944 growing season, tests of sabadilla and DDT as possible controls of various cranberry pests were made in cooperation with the United States Bureau of Entomology, with the following results:

Sabadilla in all cases was used as a 20 percent dust. At the rate of 75 pounds per acre, this dust was fully effective against the black-headed fireworm (*Rhopobota*); and at 100 pounds per acre it controlled the blunt-nosed leafhopper (*Ophiola*) reasonably well. Smaller amounts were not enough. At the rate of 100 pounds per acre, it was wholly ineffective as a treatment for the cranberry fruit worm (*Mineola*), and killed only about two thirds of the cranberry girdler (*Crambus*) moths treated.

No injury to cranberry vines or blossoms from sabadilla was observed. It was not liked by the growers because of its sternutative effects on those handling it. This seems to be a fair stop-gap insecticide for the black-headed fireworm and blunt-nosed leafhopper, but probably will never have permanent value as a cranberry insecticide.

DDT. Fifty pounds of 3 percent dust to an acre was fully effective against full-grown gypsy moth caterpillars and the blunt-nosed leafhopper, lesser strengths not being clearly satisfactory. The 5 percent dust at the rate of 100 pounds to the acre was 80 percent effective against the cranberry fruit worm, but was clearly less satisfactory than derris or cryolite. The 5 percent dust at the rate of 100 pounds per acre, used after the flight of the moths, killed about 75 percent of the small worms of the cranberry girdler on the bog floor. No evidence appeared that DDT is injurous to cranberries at the strengths and in the amounts used. The bee situation is such that it seems dangerous to advocate the use of this material on cranberry bogs even against pests which it controls readily.

Prevalence of Cranberry Insects. The relative general abundance of cranberry insects in the 1944 season was as follows:

1. Gypsy moth infestation relatively fairly heavy throughout the cranberry section of southeastern Massachusetts.
2 Blunt-nosed leafhopper (*Ophiola*) well controlled and rather scarce everywhere on the bogs.
3 Cranberry fruit worm (*Mineola*) extremely abundant and destructive everywhere in southeastern Massachusetts except in Bristol County, more so than for many years. It may be worth noting that a similar insect, the codling moth, was also very abundant in New England this year. The fruit worm was not noticeably prevalent on bogs in Middlesex County.
4. Black-headed fireworm less troublesome than usual.
5. No firebeetles (*Cryptocephalus*) found.
6. Spanworms in general not plentiful.
7. False armyworm (*Xylena*) normal in abundance.
8. Black cutworms (*Euxoa*[1] *ypsilon*) very abundant after summer flooding of bogs to control grubs.
9. Cranberry girdler (*Crambus*) very plentiful and troublesome, due probably to reduced resanding and fall flooding caused by labor scarcity, a war condition.

[1]Essig, College Entomology, 1942, p. 476.

10. Infestations of cranberry weevil, cranberry spittle insect, and tipworm about normal.

11. Honeybees and bumblebees normally prevalent.

Weather Studies. (H. J. Franklin.) Further studies since Bulletin 402 was published in 1943 have produced additional material which has resulted in the revision of the formulas for use in reckoning minimum bog temperatures with the 7 p.m. weather data.

Winterkilling. Cranberry winterkilling in Massachusetts in the winter of 1943-44 was the most extensive and severe in the memory of the oldest growers, causing an estimated reduction in the 1944 crop of at least 30 percent. On many bogs the vines were all killed down to the ground. The extent of this damage was not surprising, for a much larger cranberry acreage than usual was not flooded when it should have been because of the lack of enough rain to build up water supplies in the fall and early winter.

The severe frost of May 18–19, which cut off all the new growth that had developed on the winterkilled bogs up to that time, and the severe drouth that prevailed most of the summer were very unfavorable to good recovery of the injured vines. In spite of this, the new vine growth by fall was satisfactory on nearly all of the damaged areas. Some growers tried to help their bogs recover by mowing off the dead vines, resanding, or fertilizing, but there is little evidence that any of these measures was definitely beneficial. They had generally resulted in an undesirable growth of runners.

Frost. The frost on the night of May 18–19, 1944, considering the date of its occurrence and the minimum bog temperatures reached (from 14° to 25° F.), was one of the most severe in Massachusetts cranberry history. It killed all the season's new cranberry growth on many bogs and caused the old cranberry foliage on a few small areas to turn dark again as in winter. The extensive injury from this frost was due partly to lack of water for flooding and partly to freezing of the vines over the frost flood on some of the colder bogs. Also, since most of the bogs were very dry and absorbed much more water than usual, many did not get flooded as soon as they should have been. It was difficult to estimate the damage to the 1944 crop because of the extensive injury from winterkilling.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Sterilizing Agents for Dairy Use. (W. S. Mueller, J. E. Fuller, and E. Bennett.) The search for new sterilizing agents which will be practical for dairy equipment was continued during the past year. A sterilizing agent for dairy use should be (1) highly germicidal in the presence of organic matter, (2) non-corrosive to metals and rubber, (3) low in cost, and (4) non-toxic to humans. The germicidal properties of 42 materials obtained from 14 manufacturers have been studied. Where the manufacturer recommended the concentration to be used, the recommendations were followed; otherwise, the material was used in 0.05 percent and 0.5 percent concentrations, and in some cases 1 percent was also used. The sterilizing properties of solutions of the different materials were determined by adding 1 ml. of raw milk to 99 ml. of the solution to be tested. After the milk had been in contact with the solution for 5 minutes, proper dilutions were made and 1 ml. quantities were plated according to the Standard Method for Milk Analysis procedure. Out of the 42 materials, 15 were effective as sterilizing agents, 7 were moderately effective, and 20 were ineffective. The classification of the materials into groups and the germicidal properties of the various groups were as follows:

Group	Effective	Moderately Effective	Ineffective	Total
Germicides and fungicides	6	2	2	10
Wetting agents	3	0	6	9
Surface active agents	3	0	2	5
Dispersing agents	0	4	0	4
Emulsifying agents	0	0	4	4
Detergents	0	1	1	2
Contact insecticides	0	0	1	1
Insecticidal spreading agent	0	0	1	1
Unknowns	3	0	3	6
	15	7	20	42

Of the effective and moderately effective materials, 3 are substituted phenols, 7 are quaternary ammonium compounds, 3 are phosphonium compounds, 8 are alkyl aryl sulfonates, and 1 is an alphatic sulfonate.

All of the effective sterilizing materials were non-corrosive to 18-8 stainless steel, but three were objectionably corrosive to monel metal.

The results to date indicate that, of the 42 materials investigated, three have possibilities of being equal to or better than chlorine for sterilizing dairy equipment, and some may have a place in conjunction with cleansing agents.

Improving the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller.) The only sure means of preventing the oxidation of fat in dairy products is to remove practically all of the oxygen from the container in which the product is packed and to replace it with an inert gas. Because of the difficulties involved, manufacturing procedures would be simplified if the same results could be obtained by the use of an antioxidant. During the past year the value of cacao shell and cocoa powder as antioxidants has been studied.

Sixteen different extracts of cacao shell and cocoa powder were prepared and tested, together with a number of other materials. Two accelerated tests, known as the Swift Fat Stability Test and the Incubation Test, were used, and the materials are listed in decreasing order of effectiveness in butter oil: Caffeic acid, gallic acid, nordihydroguaiaretic acid (N.D.G.A.), propyl gallate, tannic acid, tocopherol, palmetal-l-ascorbic acid, tetrachloropara-benzoquinone, and Viobin. The best antioxidant obtained from cacao products falls near the middle of this group. While the cacao antioxidant was not so effective as some of the other materials studied, it did have some advantages. For instance, it did not impart a foreign flavor to the butter oil, while caffeic acid, gallic acid, N.D.G.A., propyl gallate, tannic acid, and tocopherol, in equal amounts, gave an objectionable flavor; also, it was most effective in the presence of copper, which is significant because some dairy products contain 4 or more p.p.m. of copper when packed for storage.

The antioxidants were used only in accelerated tests, and final conclusions cannot be drawn until long keeping tests have been made on dried ice cream mix, dried milk, butter, and butter-type spreads.

Study of Packaged Ice Cream. (J. H. Frandsen.) Results of scorings this year indicate that bulk ice cream is more palatable than packaged ice cream as generally found on the market. The results are only preliminary, and further studies will be made in an effort to develop a packaged product that will be as palatable as bulk ice cream. When this is accomplished, it will probably result in a very much larger precentage of ice cream being sold in packaged form.

Packaged ice cream can be handled with less shrinkage and less labor than bulk ice cream. Machine-packaged ice cream can be kept at a lower temperature than bulk ice cream, and therefore keeps in better condition after it is sold to the consumer.

DEPARTMENT OF ECONOMICS
Philip L. Gamble in Charge

Effects of the War and Readjustments in Massachusetts Agriculture. (David Rozman.) Work on this project centered largely on investigation of undeveloped rural land areas as a possible factor in desirable land use adjustment of farming units in the post-war period. An intensive phase of this study was carried out in the towns of Uxbridge, Hubbardston, and Southwick. Further analysis was made of AAA records and other current material in determining the trend and volume of Massachusetts agricultural production.

The preliminary results of the land use factor, especially as derived from an intensive study of the towns of Uxbridge, Hubbardston, and Southwick, indicate that undeveloped areas not in farms offer considerable opportunities for possible readjustment of existing farm units. In some favorably located areas opportunities are also present for a limited number of additional farms. The limiting factors are an irregular distribution of available land, the complicated pattern of land ownership, and the cost of bringing the land into use.

The findings under this project bearing on the major factors involved in agricultural production are of continuous importance in achieving the desirable pattern of Massachusetts agriculture under wartime conditions. They are expected also to pave the way for an orderly transition to peacetime conditions and for placing agriculture in the State on a more stable basis.

In connection with this program of readjustment of Massachusetts agriculture the manuscripts prepared are: (a) 1945 Wartime Production Capacity of Massachusetts Agriculture; and (b) A Post-War Production Pattern for Massachusetts Agriculture.

DEPARTMENT OF ENGINEERING
C. I. Gunness in Charge

Cranberry Storage Investigation. (C. I. Gunness, H. J. Franklin, and H. F. Bergman.) The storage of cranberries was continued during the 1944 season. Berries were stored at 45 degrees in a normal atmosphere and also in a controlled atmosphere where the carbon dioxide content was kept at approximately 10 percent, oxygen at 10 percent, and the balance was nitrogen. Berries similar to those stored at 45 degrees were also stored in an air-cooled screenhouse. The berries were picked and stored on September 9 but the controlled-atmosphere room was not sealed until September 11.

On September 14 the hurricane disrupted power service and service was not restored until September 25. The temperature rose to 53 degrees in the two rooms which were supposed to be kept at 45 degrees.

The storage losses as determined by screening on October 6 were as follows: 45-degree room, normal atmosphere, 4.4 percent; 45-degree room, controlled atmosphere, 2.9 percent; screenhouse, 7.1 percent. Berries stored in the controlled atmosphere had colored less than those stored in normal atmosphere. In comparing loss in the screenhouse with that in the rooms held at 45 degrees, it should be recalled that the temperature in the latter rooms actually rose to 53 degrees between September 14 and September 25.

Poultry House Investigation. (C. I. Gunness and W. C. Sanctuary.) The poultry housing studies were continued during 1944-45 with special emphasis on ventilation and arrangement of equipment to permit a reduction in the num-

ber of square feet allowed per bird in the pen. The electric ventilation system was rebuilt so as to use a smaller duct, and the outlet from the duct increased in size to reduce drafts across the floor. The main features of circulating a relatively large volume of air across the floor and the introduction of a small amount of fresh air were retained. Windows were kept closed throughout the season, the sole intake of air being through a 6″ pipe in a pen housing 100 birds. Temperatures were kept higher than would have been possible in this uninsulated house with slot or window ventilation. Litter remained good.

In another pen, slot ventilators were baffled, which permitted placing roosts and elevated feed hoppers well toward the front of the house without fear of drafts. The new arrangement permitted increasing the number of birds until only 3 square feet of floor space per bird was allowed in place of the conventional 4 square feet. This was accomplished without sacrificing the health of the birds or loss of egg production.

Hay Drying. (C. I. Gunness, J. G. Archibald, C. H. Parsons.) Equipment was installed in one of the college barns in 1944 for curing hay partially cured in the field. A system of ducts was installed on the barn floor and air blown into these ducts, the air being forced up through the partially cured hay. About 40 tons of hay were cured, the greater portion of which was put into the barn with a moisture content of 45 percent. The hay was cured satisfactorily and indications are that this system can be used in New England with considerable success.

The trial is continued during the current season and another installation has been made for curing baled hay.

DEPARTMENT OF ENTOMOLOGY
Charles P. Alexander in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb.) Work in connection with the cooperative project with the Dow Chemical Company was continued, both at Amherst and Waltham.

Tests in different blocks of the college orchard and in nearby commercial orchards supported previous results and showed that DN-111 or D-4 properly applied were dependable to a very high degree in subduing summer outbreaks of European red mite. In one of the experimental blocks in which tests were being made of DDT as a replacement of lead arsenate, red mite apparently suffered no inconvenience from repeated applications of DDT and by early July had increased to an average of 175 mites per leaf. DN-111 in one application reduced the population to an average of 1.5 mites per leaf within 24 hours, and no serious later build-up took place.

DN-111 and D-4 applied to beach plums heavily infested with red mite reduced the mites almost to the point of extinction.

In several commercial orchards the owner applied DN-111 following standard directions and secured as satisfactory control as in our own test blocks. This supported our contention that, if the material is thoroughly applied (trees sprayed from the ground), DN-111 can be expected to give a high degree of control, and that D-4 dust will give practically as good results if sufficient time is taken to insure thorough coverage.

Trees of Wealthy, Cortland, and Baldwin varieties were given 5 applications of DN-111 plus wettable sulfur plus lead arsenate between May 20 and August 11. No injury was noted on any variety. The season of 1944 was not of a type to induce spray burn of any type so that while these tests are encouraging they need to be supported by further work in a more normal year.

Tolerance tests of DN-111 and lead arsenate and wettable sulfur were made on peaches, plums, and cherries. Two applications were made: the first, an equivalent of late shuck spray, on May 29, and a later spray on July 13. No injury was noted.

Tolerance tests of both DN-111 and D-4 were made on 10 different types of ornamentals during the period between May 31 and July 18. Considerable foliage injury was observed on several plants following the May application. Unmistakable burning, though less severe, resulted from early June application. Injury was noticeably less following late June application, and very little or no injury resulted, even on susceptible varieties, following July applications.

The scarcity of apple leafhoppers in both early and late season throughout the State made it impossible to run the tests planned against these insects.

At Waltham, dormant applications to apples having a light infestation of overwintering red mite eggs resulted in a reduction of live mites on May 16 from 170 mites per 100 spurs where no treatment was applied to 39 mites per 100 spurs following miscible oil 3.3 percent actual oil, and to 129 mites per 100 spurs following DNOC powder at the rate of 3 pounds in 100 gallons. By August 1 no significant difference in the number of mites was found, indicating that the effect of the dormant spray had been lost.

Studies of Different Forms of DDT. (A. I. Bourne and W. D. Whitcomb.) The work on DDT in its various forms was conducted in cooperation with the Crop Protection Institute, and all of the materials were furnished by the Geigy Company, Inc., New York City. Tests of DDT were made in all of the outstanding field projects and are reported under those projects, and in addition special laboratory and field tests were made on as many particular species of insect pests as possible.

Rose Chafer. In laboratory tests Gesarol A-20 and A-3 gave very promising results against rose chafer. In the first series of tests the materials were applied in a light application to grape foliage, and beetles were then placed on the leaves. In 6 days 90 percent of the beetles on dusted foliage were dead and only 50 percent on sprayed leaves. In a second test, foliage was given a heavy dusting with A-3, and 80 percent of the beetles were dead after 2 days and 90 percent at the end of 3 days. In a series in which the beetles were sprayed or dusted and then placed on grape foliage which was also sprayed or dusted, 90 percent of the sprayed beetles and all of the dusted beetles had died by the second day. In a fourth series, beetles were sprayed or dusted and placed on untreated grape foliage. After 2 days 80 percent of the dusted beetles and 74 percent of the sprayed beetles were dead, and at the end of 5 days all had died. In this time 4 percent of the untreated beetles died in the 2-day period, 2 percent more after 3 days, and 10 percent at the 5-day period.

Japanese Beetle. Gesarol A-20 spray and Gesarol A-3 dust were fully as effective against Japanese beetles as against rose chafer. The beetles seemed to be rendered inactive within a few hours after treatment and no recovery was noted. In all cases the beetles had been treated and then placed on fresh foliage.

In a comparison of DDT with other insecticides, all beetles treated with DDT spray or dust were dead by the second day, while all were alive in lots treated with cryolite spray and copper rotenone dust. In the lot treated with Lethane B-72, 20 percent of the beetles were dead after 2 days and most of the remaining beetles were more or less inactive. During this period of 2 days, only 3 percent of the untreated beetles had succumbed.

Striped Cucumber Beetle. DDT was very toxic to striped cucumber beetles. Within a short time after treatment the beetles became inactive and ceased feeding, and in 24 hours all were dead, while all beetles dusted with rotenone succumbed within 12 hours. DDT was not quite so rapid in its actual killing effects as rotenone; but since all treated beetles ceased feeding and became inactive within a few hours after treatment, from a commercial standpoint they ceased to function as pests so that the actual time of death was of secondary importance. No injury to foliage was noted in laboratory tests. The beetles appeared late in the season when the plants had made considerable growth and no injury from the treatment was observed such as was reported from tests in other states where applications were made in early season when the plants were small and very tender.

Squash Bug. This insect was relatively scarce in the vicinity of Amherst and only laboratory tests on a few specimens were possible. In each series DDT killed young-stage bugs up to and including half-grown nymphs. Later stages were quite resistant, and adult bugs seemed to be only slightly affected.

Black Scale. Gesarol A-20 at a dosage of 4 pounds to 100 gallons proved very effective in the control of black scale on gardenias. The immediate effects were very pronounced and the material showed a definite residual action which prevented reinfestation and from a commercial standpoint eliminated the pest.

Plum Curculio, Codling Moth, and Apple Maggot. Insectary poison studies at Waltham with a commercial preparation of DDT (Gesarol A-20) used at the rate of ¼, ½, ¾, and 1 pound of DDT per 100 gallons of water showed this material to be surprisingly ineffective against the plum curculio on apples. Further studies on a caged apple tree sprayed with the material corroborated the insectary studies with plum curculio, but indicated promising effectiveness against codling moth and apple maggot flies.

Flies. Experiments against adult flies were conducted mainly in the college piggery. On June 21 two pens were sprayed with a solution of 2 gallons of water and 38 cc. of Gesarol SH5, and two pens were sprayed with a solution of 2 gallons of water and 18 grams of Gesarol A-20. An immediate reduction in flies occurred. Dead flies were found on both the treated and the untreated sides. Daily inspections revealed a comparative absence of flies until June 24, when a few were found on the treated side of the piggery during a heavy rain. At the end of a week the flies were present in relatively the same number on both the treated and the untreated sides. Troughs treated with DDT remained free from flies during the experiment.

Experiments against fly larvae in infested manure were conducted. Applications were made on July 19 to 3 pens in the sheep barn. A solution of 1 pint of Gesapon-18 to 10 gallons was employed at rates of 3, 6, and 9 gallons to 27 square yards. In addition 15 square yards of fly-infested soil near the feeders were treated with the material at the rate of 1 gallon of 1 percent solution per square yard. The following day, examination revealed the presence of live larvae in all treatments, both in the sheep barn and at the piggery, indicating that DDT at the concentrations used was not effective. Subsequent examinations bore this out.

The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts. (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) The tests in 1944 included studies of the effectiveness in insect control of more accurate timing of applica-

tions, the value of nonarsenical insecticides to supplement the standard schedule, and a study of one form of DDT (Gesarol-20) as an orchard spray material.

All materials were used in combination with wettable sulfur to determine their compatibility and effectiveness in disease control. Special emphasis was laid on the emergency codling moth spray interposed between the 2d and 3d cover sprays and intended to fill the gap existing between mid-June and early July. Records were taken from the McIntosh variety. Fruit from these trees was harvested just before the hurricane of September 14–15. Scab proved to be a minor factor and was well controlled in all plots.

Although in the unsprayed check plot 66 percent of the fruit was more or less scarred by curculio, yet the spray applications timed on temperature ranges were sufficiently accurate to hold the pest in check very satisfactorily except in the plots where DDT replaced lead arsenate. DDT failed to check curculio and 35.6 percent of the fruit in this plot showed curculio damage.

Codling moth proved to be a more difficult problem. Following the standard schedule there was 15 percent injury. One application of fixed nicotine reduced codling moth injury by approximately 2 percent. Two applications of fixed nicotine, however, reduced injury by this species to 5 percent, and a modified schedule employing DX-nicotine in combination with reduced dosage of lead arsenate held codling moth injury to approximately 3 percent. An emergency application interposed between the 2d and 3d cover sprays still further reduced codling moth damage to 1.4 percent.

DDT failed to check plum curculio activity to any marked degree and allowed 10 percent codling moth damage but proved slightly superior to the standard schedule against apple maggot.

The addition of magnesium sulfate to the spray combination, to correct magnesium deficiency, caused no injury to leaves or russeting of fruit and had little or no effect upon the toxicity of the sprays to either insect pests or plant diseases.

A heavy deposit-building dust to protect fruit from late-season stings by codling moth showed definite possibilities. Codling moth damage in dusted plots was only slightly more than half that in adjoining sprayed plots. The dust also held scab successfully.

Insecticides for the Control of European Corn Borer. (A. I. Bourne.) A large second brood of European corn borer in 1943, coupled with a mild winter and very little snowfall, produced one of the heaviest carry-overs of larvae in Massachusetts in recent years. Relaxing of clean-up measures left much of the corn standing in the fields, and winter mortality was practically nil. There was every indication of a very heavy infestation for the 1944 season. Hot, dry weather throughout May evidently retarded pupation, which was very slow until the period of one or two light rains about mid-May but proceeded rapidly thereafter. However, during the period of moth activity very unfavorable weather intervened and egg laying was seriously retarded. As a result, throughout practically the entire state, the infestation of early sweet corn was not serious and was very much lighter than anticipated.

DDT spray (Gesarol A-20 at 2 pounds to 100 gallons) and dust (A-3) gave almost perfect control.

Black Leaf 155 at the rate of 2 pounds to 100 gallons was sufficiently effective to indicate that against a light infestation this dosage would give good commercial control if the application was properly timed. Black Leaf 155 at 3 pounds to 100 gallons dosage and derris (4 percent rotenone) spray at 4 pounds to 100 gallons gave better than 97 percent control. As indicated above, the infestation was too light to show any significant difference between treatments. The borer population in the unsprayed checks averaged only 1 to 2 larvae per plant.

Potato Spraying Experiments. (A. I. Bourne.) The experimental plots were planted May 9. The young plants appeared within the next 10 to 14 days and averaged 5 to 6 inches in height at the time of the first application on June 12.

During the early season (June and July) the infestation by flea beetles was comparatively light. In late July the number of beetles increased rapidly and continued high until mid-August when the infestation dwindled rapidly and very little scarring of foliage was caused thereafter. There were very few leafhoppers throughout the entire season. Comparatively little damage was caused by European corn borer larvae, and although the potatoes adjoined a plot of field corn the number of second-brood moths hiding during the day in the potato vines was not great. This was in marked contrast to 1943. No late-season damage to potato vines was noted. No serious outbreak of potato aphids occurred. An incipient attack was noted about mid-July and nicotine sulfate was included in the application on July 20. No further steps in control were necessary.

Bordeaux mixture at standard strength of 10-10-100 was applied to the east and middle plots. Calcium arsenate at the rate of 4 pounds to 100 gallons was added to the bordeaux in half of the east plot. DDT (Gesarol A-20) at 2 pounds to 100 was added in one half of the middle plot. Bordeaux at strength of 5-10-100 alone, with calcium arsenate, and with DDT was applied in the west plot. Eleven applications were made at approximately weekly intervals between June 12 and August 28. The new Friend field crop sprayer with a 6-row boom (3 nozzles per row) was used throughout the season and rendered excellent service.

The plants in plots which received the low-copper bordeaux began to ripen and die down in late August and early September. Plants in the plots which received full strength bordeaux for the most part persisted throughout September and many plants were alive and green until they were killed by the frost of October 4–5. The plants suffered considerable damage by the high wind of the hurricane on September 14–15 and from the heavy rain which accompanied it. The injury was aggravated by the period of hot, humid weather which immediately followed the hurricane.

The early ripening of plants in the plots which received the low-copper bordeaux schedule was reflected in the yield, which averaged 320 bushels per acre compared with a yield of 369 bushels per acre in the plots sprayed with standard 10-10-100 bordeaux. The plots in which calcium arsenate and DDT were added to bordeaux (standard strength) yielded approximately 20 bushels per acre more than corresponding plots which received bordeaux alone.

In the series of plots which received standard bordeaux, the addition of calcium arsenate was accompanied by a distinct and immediate reduction of nearly 50 percent in the amount of flea beetle damage. This ratio held through successive weeks. The addition of DDT did not give such noticeable reduction immediately, but showed a cumulative benefit from successive applications which resulted in marked reduction in the number of leaf punctures. Where the low-copper bordeaux alone was applied, practically the same degree of protection against flea beetle was secured as was furnished by standard strength bordeaux. The addition of calcium arsenate or DDT in these plots did not noticeably increase the degree of immediate protection although there was some evidence of beneficial cumulative effects following successive applications.

Control of Onion Thrips. (A. I. Bourne.) Application of a dinitro dust (DN-4) gave 97.5 percent reduction in thrips population but caused slight burning of the plants. Lethane (B-71) dust gave 78 percent reduction with no injury. DDT (Gesarol A-3) dust proved only moderately effective with a reduction of 44 percent. Very heavy applications greatly increased the effectiveness of Lethane

and DDT dusts, in both cases giving higher than 88 percent reduction in the number of thrips, which is a very satisfactory control.

Of the sprays applied, nicotine sulfate with Pine Tar soap gave excellent results by providing an effective control of better than 97 percent. Derris powder with the addition of a wetting agent (Ultrawet) ranked very close to nicotine sulfate, causing 95 to 97 percent reduction in thrips population and furnishing very definite residual effects which prevented reinfestation. DDT (Gesarol A-20) spray alone gave 87 percent control, and when used with a wetting agent 91.4 percent control. All of the materials used as sprays proved entirely safe and caused neither immediate burn nor any retardation of growth.

Biology and Control of the Celery Plant Bug. (W. D. Whitcomb and Wm. Garland, Waltham.) The celery plant bug (*Lygus campestris* L.) was much less abundant in 1944 than in the two previous years and the infestation in the experimental plantings at Waltham was extremely light. Nevertheless, considerable "blackheart" developed in the early celery, apparently due to a frost on May 19, 1944, followed by abnormally dry weather. Although many plants on which no bugs were observed in semi-weekly observations developed "blackheart", some correlation between "blackheart" and plant bugs was indicated by the presence of 1 (first generation) or 2 (second generation) more bugs per "blackheart" plant than on normal plants. Yellow varieties of celery averaged about 2 more plant bugs per plant than green varieties; and Summer Pascal, the favorite variety in this area, appeared more resistant to plant bug infestation.

With infestations averaging about 20 plant bugs per 100 plants, 2 or 3 applications of insecticides gave excellent protection. Pyrethrum dust containing .2 percent pyrethrins with and without sulfur, and a commercial thiocyanate dust called B-71 gave perfect control after each application, and a .5 percent rotenone dust was satisfactory.

Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb and Wm. Garland, Waltham.) Experimental fumigations with chlor naphthalene mixtures to recheck a few critical factors in the use of this material were completed.

Preliminary fumigations with alpha bromo naphthalene showed reasonable toxicity to the common red spider but also gave indications of plant injury. However, this material is considered sufficiently promising to warrant further investigation.

Biology and Control of the Grape Cane Girdler. (W. D. Whitcomb and Wm. E. Tomlinson, Jr., Waltham.) The grape cane girdler was naturally scarce in 1944, and the time allotted to this project was temporarily transferred to other work.

Apple Maggot Emergence. (W. D. Whitcomb.) Apple maggot flies began to emerge in the cages at Waltham in 1944 on June 14, the earliest date since the cages have been in operation. Favorable conditions permitted some of the flies to live until early October and created an unusually long period of activity for this pest.

	Cultivated Soil	Sod
First Fly Emerged	June 14	June 14
25 Percent of Flies Emerged	June 23	June 26
50 Percent of Flies Emerged	July 3	July 3
75 Percent of Flies Emerged	July 14	July 13
Last Fly Emerged	June 26	June 26
Percent of Flies Emerged	66	45

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) Dosage experiments using ¾, 1, and 1¼ gallons of spray per 100 square feet of surface area of the tree were continued with special emphasis on the effect of this factor in controlling the plum curculio in a heavy crop of apples. During the experiments 246,000 apples were examined. The results indicated that the 1¼ gallon dosage was definitely more effective and that the ¾ gallon dosage was unsatisfactory. The 1-gallon dosage was inconsistent, and suggested that the margin was so slight that the results might be affected by factors which were not measured. The influence of dosage on control of the codling moth was even more significantly in favor of the 1¼ gallon treatment.

Cryolite again proved less satisfactory than lead arsenate against the plum curculio in apples.

During the hot weather in late June and early July many dropped apples infested with plum curculio larvae were burned by the sun. Emergence of larvae from normal apples was 39.4 per 100 fruits; from one-half burned apples, 2.66 per 100 fruits; and from completely burned apples 0.20 per 100 fruits.

Introduction of Parasites of Oriental Fruit Moth in Peach Orchards. (A. I. Bourne.) Because of the war emergency it was not possible to conduct the oriental fruit moth parasite-rearing project in 1944.

Control of Cabbage Maggot. (W. D. Whitcomb, Waltham.) With normal heavy field infestation by the cabbage maggot, untreated plants of the Early Jersey Wakefield and Charleston Wakefield varieties again showed about 25 percent less injury, and produced 30 to 50 percent more marketable heads than Golden Acre and Super Curled Savoy varieties. Penn State Ballhead also showed considerable resistance.

Tar paper pads and 4 percent calomel–talc dust both gave more than 90 percent control, and corrosive sublimate solution 1-1280 in two applications was satisfactory with 84 percent control. Talc alone gave no protection, and reduced dosages of 2 percent calomel–talc and corrosive sublimate solution 1-2560 in two applications were unsatisfactory against a very heavy attack.

The number of eggs laid on each variety in the period May 6–31 varied from 29 to 14 per plant, with the largest number being found on Charleston Wakefield which showed the least injury, indicating that resistance results from the ability of the plant to resist injury rather than from any repellent action to the flies during oviposition.

Biology and Control of the Red Spider Mite on Greenhouse Crops. (W. D. Whitcomb, Wm. E. Tomlinson, Jr., and Wm. Garland, Waltham.) Applications of two forms of DNOCHP containing 20 and 13.3 percent of active ingredient respectively killed approximately 97 percent each of the red spider on greenhouse roses when reduced to equal amounts of DNOCHP by using 8 and 12 ounces respectively in 100 gallons of water. This indicates that a definite concentration of DNOCHP is necessary, whether applied in one heavy application or several light applications. Proprietary sprays containing naphthalene and azo-benzene both gave excellent control of red spider but caused injury to rose foliage.

A proprietary spray containing the extract of yam bean and one containing B-butoxy-b'thiocyanodiethyl ether were both inconsistent and in general gave unsatisfactory control of red spider on greenhouse roses when used according to manufacturer's directions.

Control of the Squash Vine Borer. (W. D. Whitcomb, Waltham.) Studies of the susceptibility of different genera of the family Cucurbitaceae to attack by the squash vine borer showed the *Cucurbita maxima* was most heavily infested. The

varieties Blue Hubbard, Warren Turban, and Buttercup squash averaged 3.31 borer injuries per vine. Six varieties of *Cucurbita pepo*, including pumpkin, gourd, and four types of summer squash, averaged 2.23 borer injuries per vine, with the straightneck summer squash the most heavily infested. *Cucurbita moschata*, represented by the Butternut squash, was not infested and appeared to be immune.

Cucumis sativis, the cucumber; *C. melo*, the cantaloupe; and *Citrullus vulgaris*, the watermelon, also were not infested.

New Insect Pests of Importance in 1944. (W. D. Whitcomb, Waltham.) Outbreaks of the spotted tentiform leaf miner (*Lithocolletis blanchardella* Fab.) occurred in a few orchards in the Nashoba district causing serious injury to apple foliage and accentuating drouth damage. These outbreaks were located in orchards where the infestation was light in 1943. The orchards which were heavily infested in 1943 had little or no infestation in 1944. Six species of parasites were reared from *L. blanchardella*, which apparently explains the absence of the leaf miner following heavy infestations the previous year.

Spraying Log Piles to Prevent Scolytid Infestation of Elm Logs. (W. B. Becker.*) In the spring, between 10 and 21 uninfested elm logs (with bark up to 1 inch thick on xylem up to 11 inches in diameter) were scattered uniformly throughout log piles measuring 4x4x4 feet. Power sprayers were then used to direct various sprays into the piles from the ends of the logs and the top of the pile. At Springfield, a single-nozzle, adjustable-stream spray gun was used at 400 pounds pressure; at Great Barrington, a similar spray gun was used at 100 to 250 pounds pressure; and at Amherst, a six-nozzle spray boom was used with a power sprayer which gave 400 pounds pressure. *The results are based on the number of exit holes per square foot of elm bark found in the logs after late fall.* The figures following each spray mixture indicate the proportion of ingredients and the amount applied per log pile.

	Percent Prevention
At Springfield (practically all the elm scolytids were *Scolytus multistriatus*)	
Orthodichlorobenzene and No. 2 fuel oil (1-8, 20 gals.*)	100.0
Bordeaux and water (1 lb. – 5 gals., 20 gals.)	61.2
Gesarol SH5 (5% DDT in a summer spray oil) and water (1-100, 20 gals.)	78.1
At Great Barrington (*Hylurgopinus rufipes* was the only or predominant elm scolytid present)	
Gesarol SH5 and water (1-100, 35 gals.)	64.3
Orthodichlorobenzene and No. 2 fuel oil (1-8, 8 gals.)	6.3
No. 2 fuel oil alone (8 gals.)	86.0
At Amherst (*H. rufipes* was the only elm scolytid present)	
Gesarol SH5 and water (1-100, 14 gals.)	92.8
Gesarol SH5 and kerosene (1-100, 14 gals.)	93.6
Orthodichlorobenzene and No. 2 fuel oil (1-8, 16 gals.)	100.0

*Approximately 300 cc. per square foot of bark.

Spraying Log Piles to Kill Elm Scolytids. (W. B. Becker.) In midsummer, log piles of the same size used for the prevention sprays, but containing logs from which beetles were ready to emerge, were similarly sprayed with the same equipment. *The percentages given are based on the number of exit holes per brood gallery, as compared with the emergence from unsprayed logs.* The figures following each spray mixture indicate the proportion of ingredients and the amount applied per log pile.

*The author is deeply indebted to Mr. L. Fletcher Prouty, Assistant Superintendent in the Springfield Department of Public Parks, who provided much material assistance in carrying out all the experiments in Springfield.

	Percent Control
At Springfield (*Scolytus multistriatus* outnumbered *Hylurgopinus rufipes* brood galleries by approximately 5 to 4 and 5 to 1 in the various piles)	
Orthodichlorobenzene and No. 2 fuel oil (1-8, 20 gals.)	88.5
Orthodichlorobenzene, D. I. Lestoil, and water (2.5-1-20, 20 gals.)	46.7
Gesarol SH5 (5% DDT in a summer spray oil) and water (1-100, 20 gals.)	9.3
At Great Barrington (*H. rufipes* outnumbered *S. multistriatus* brood galleries by between 10 to 1 and 3 to 1 in the various piles)	
Gesarol SH5 and water (1-100, 20 gals.)	8.6
Orthodichlorobenzene, D. I. Lestoil, and water (3-75-1.5-30, 20 gals.)	59.6
Elgetol, D. I. Lestoil, and water (1-0.5-50, 20 gals.)	74.7
At Amherst (only *H. rufipes* was present)	
Gesarol SH5 and water (1-100, 15 gals.)	0.0
Orthodichlorobenzene, D. I. Lestoil, and water (1.9-0.8-15.0, 15 gals.)	73.4
Orthodichlorobenzene and No. 2 fuel oil (1-8, 15 gals.)	100.0

Sprays to Prevent Scolytid Infestation of Individual Elm Logs. (W. B. Becker.) At Amherst, the following spray mixtures applied to the entire surface of individual elm logs (up to 9 and 17 inches in diameter with bark up to 9/16 and ¾ inch thick) just prior to beetle fllight in the spring gave the indicated percentages of prevention of *Hylurgopinus rufipes* infestation *based on the number of exit holes per square foot of bark* in the late fall, as compared with unsprayed logs. The figures following each spray mixture indicate the proportion of ingredients and the amount applied per square foot of bark service.

	Percent Prevention
Creosote and kerosene, strained (1-4, 138 cc.; also 1-8, 142 cc.)	100.0
Orthodichlorobenzene and No. 2 fuel oil (1-12, 170 cc.; also 1-8, 113 cc.)	100.0
Gesarol SH5 (5% DDT in summer spray oil) and kerosene (1-200, 141 cc.; also 1-100, 136 cc.)	100.0
Kerosene alone (164 cc.)	100.0
Gesarol SH5 and water (1-100, 169 cc.)	78.4
Gesarol SH5 and water (1-200, 131 cc.)	71.7
Dowax, Gesarol SH5, and water (1184-38-3547, 145 cc.)	50.2
Dowax and water (1-3, 159 cc.)	0.0

At Springfield, the following spray mixtures were applied to the entire bark surface of individual logs (up to 7 and 11 inches in diameter with bark up to 7/16 and 3/4 inch thick at ridges) when scolytids were beginning to attack them in mid-June. The indicated percentages of prevention of scolytid infestation *are based on the number of brood galleries which became established per square foot of bark surface*, because of the preliminary nature of the experiment. *Scolytus multistriatus* was the only or predominant scolytid in the logs.

	Percent Prevention
Orthodichlorobenzene and No. 2 fuel oil (1-8, 117 cc.; also 1-12, 110 c.c)	98.3
No. 2 fuel oil alone (105 cc.)	97.7
Cuprinol (a commercial preservative used for wood, rope, etc.) alone (98 cc.)	93.0
Creosote and kerosene, strained (1-8, 84 cc.)	92.6
Creosote and kerosene, strained (1-4, 72 cc.)	90.0
Gesarol SHN20 (20% DDT in an oil) and kerosene (1-100, 94 cc.)	79.8
Creosote, D. I. Lestoil, and water (946-757-3785, 99 cc.)	75.4
Kerosene alone (98 cc.)	72.1
Gesarol A20 (20% DDT in a dry spray concentrate) and water (18 gm.-3578 cc., 76 cc.)	59.9
Dowax and water (1-3, 99 cc.)	57.4
Creosote, Aresklene (a commercial emulsifier), and water (946-47-3785, 88 cc.)	52.7
Kerosene alone (19 cc.)	50.6
Ammonium sulfamate (a weed killer) and water (454 gm.-3785 cc., 90 cc.)	48.6
Orthodichlorobenzene, D. I. Lestoil, and water (473-142-3785, 86 cc)	19.4
Gesarol SH5 and water (1-100, 67 cc.)	12.2
Zinc chloride and water (189 gm.-3785 cc., 128 cc.)	5.4
Gesarol SHN20 and kerosene (1-100, 19 cc.)	0.0

Sprays to Kill Scolytids Breeding in Individual Elm Logs. (W. B. Becker.) At Amherst, the following spray mixtures were applied to the entire bark surface of individual elm logs (up to 12 and 21 inches in diameter with bark up to 5/8 and 3/4 inch thick) and gave the indicated percentages of control based on the number of exit holes per brood gallery in the late fall. The figures in parentheses following each spray mixture indicate the proportion of ingredients and the amount applied per square foot of bark surface.

	Percent Control
Orthodichlorobenzene and No. 2 fuel oil (1-8, 135 cc.)	99.9
Creosote and kerosene (1-4, 119 cc.)	97.6
Kerosene alone (113 cc.)	91.1
Orthodichlorobenzene D. I. Lestoil, and water (1-0.3-8, 166 cc.)	80.7

The Prevention of Elm Scolytid Infestation by Solar Heat. (W. B. Becker.) At Amherst, freshly cut elm logs lying in a north-south direction in the sun were rolled 180 degrees of their circumference (1) every week and (2) every three weeks during the early season oviposition period (May 18–June 23). After the latter date none were disturbed until after the beetle's active season had ended. Compared with the number of exit holes per square foot of bark in unturned check logs in the sun, 99.7 percent control resulted from weekly turning of logs between 3 and 13 inches in diameter, with bark up to 7/16 inch thick. Turning every three weeks gave 93.5 percent control in logs between 4 and 21 inches in diameter, with bark up to ½ inch thick. *Hylurgopinus rufipes* was the only elm scolytid found in the logs.

At Westfield, similar experiments conducted between June 10 and July 15 with logs up to 7 inches in diameter having bark up to 5/8 inch thick gave 100 percent control with both treatments. *H. rufipes* was much more abundant than *Scolytus multistriatus* in the logs.

At both localities the beetle galleries reached a more advanced stage in the logs which were turned every three weeks than in those turned every week. The larger logs usually had more brood galleries than those of small diameter, those less than 5 inches in diameter having none at all even among the unturned check logs.

Combined Use of Sprays and Solar Heat on Individual Elm Logs to Prevent Elm Scolytid Infestation. (W. B. Becker.) At Amherst, slightly more than the upper half of freshly cut, uninfested elm logs, 3 to 14 inches in diameter, with bark up to 1 inch thick, and lying in a north–south position in the sun, were sprayed in the spring with creosote and kerosene (strained), 1 to 4 by volume, and then rolled over so the sprayed side was turned down. Compared with unsprayed logs similarly placed, 99.8 percent prevention resulted, based on the number of exit holes found per square foot of bark after the beetle's active season had ended. The only area infested was a small patch of bark on the under side of one log, which was not covered by the spray. *Hylurgopinus rufipes* was the only elm scolytid present.

At Westfield, 100 percent control resulted from similar treatment of elm logs up to 7 inches in diameter, with bark up to 3/8 inch thick. *H. rufipes* was much more abundant than *Scolytus multistriatus* in the control logs.

Some logs less than 10 inches in diameter, which were similarly treated at Amherst on July 2, 1943, and which were left exposed to beetle attack through 1944, did not become infested. However, since unsprayed check logs which lay in the sun did not become infested either, it may be assumed that these logs were too seasoned for scolytid infestation by the spring of 1944.

Effect of Dry Storage on Hylurgopinus rufipes Infestation of Elm Logs. (W. B. Becker.) At Amherst, winter-cut logs were piled in three dry structures before *H. rufipes* oviposition began in the spring. These structures were two different barns, the large doors of which were often open, and the basement of a building, the small door of which was usually closed. The logs used were about 18 inches long, between 2 and 8 inches in diameter, and had bark up to ½ inch thick.

Compared with the number of exit holes per square foot in logs piled outdoors in the shade, 96.4 and 99.5 percent control resulted from storing the logs in the barns, and 99.6 percent from storing the logs in the basement. In addition to the possibility of the beetles flying to the logs after they are stored, it must be remembered that *H. rufipes* commonly spends the winter on the trunks of live elm trees and so may be brought indoors on logs cut during that time. The dryness indoors, of course, is unfavorable to the development of those beetles which do become established in the logs.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) The Field Station strains of snapdragons continue to show a high degree of resistance to rust disease in the field and greenhouse. Thirty selections made of resistant lines yielded only seven showing rust, and these showed relatively little rust, being from 10 to 25 percent susceptible. First-generation hybrids of the rust-resistant strains have been much more vigorous than inbred lines. These hybrid types cannot be used for seed production but do give more uniform bloom, flower color, and plant growth. Since at present this type of breeding is practiced on a limited scale with florist's crops, it offers an interesting field of study.

A large flowered, pink snapdragon developed from the Field Station strains was named Helen Tobin, in honor of the wife of the Governor of Massachusetts. Responsibility for distribution of seed of this new variety of winter-flowering snapdragon has been assumed by the Northeastern Regional Unit of the Society of American Florists.

Disease Resistance and Heredity of Carnations. (Harold E. White, Waltham.) Carnation seedling plants have been selected from crosses made between disease-resistant and susceptible varieties of carnations. These plants are to be tested for disease resistance, and promising material will be used for further breeding. Pollination work under glass in winter has not given a satisfactory set of seed on many crosses that have been attempted.

Cultural Treatments of Anemone coronaria. (Harold E. White, Waltham.) Anemone tubers soaked 24 hours in warm water, or sprouted in sand in the propagation house, grew much more rapidly than tubers planted dry in the soil. Flower production was greater on treated tubers than on untreated.

Division of the tubers into too small units resulted in decreased flower production. Better flower production and more plant growth were obtained from fertilizer containing nitrogen than from phosphate or potash alone. Anemones made excellent growth and flowered as abundantly in gravel as in soil.

Effect of Fungicidal Hormones on Carnation and Geranium Cuttings. (Harold E. White, Waltham.) Cuttings of eight varieties of carnations treated with Hormodin Power No. 1 and Stimroot powder showed no difference in degree of

rooting. Cuttings treated with Fermate, used dry and as a liquid solution, showed no differences in rooting response. The Stimroot powder contains Spergon, a fungicide, combined with a rooting hormone; while Fermate is a straight fungicidal material. Since cutting-rot disease was not prevalent in the propagation bench, little can be said as to the respective merits of these materials.

Geranium cuttings were treated with Hormodin powder Nos. 1, 2, 3, Telluric rooting powder No. 66, and Rootone. The Hormodin powders No. 2 and 3 contain more rooting chemicals than No. 1, hence are recommended for use on woody plants more difficult to root. The purpose in using the stronger hormone powders was to determine whether over-abundance of callus tissue, or injury brought about by too much hormone powder, might cause greater losses from rot diseases. The percentages of cuttings lost from rot were as follows: Hormodin 1, 50 percent; Hormodin 2, 47 percent; Hormodin 3, 76 percent; no treatment, 56 percent. Results with the other hormone powders were comparable to those with Hormodin 1. The results of these tests indicate that too much root hormone powder, or a highly concentrated powder, may cause cuttings to be more susceptible to rot diseases.

The treatment of geranium cuttings with copper carbonate and malachite green did not reduce cutting-rot losses in the propagation bed. -

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DEPARTMENT OF FOOD TECHNOLOGY

F. P. Griffiths in Charge

The Nutritive Value of Mushrooms. (W. B. Esselen, Jr., A. Filios, W. H. Fitzpatrick, and E. Weir.) Quantitative data on the amino acid content of mushrooms (*Agaricus campestris*), obtained by microbiological assay methods, showed that they contain approximately 203 mg. of argenine, 458 mg. of isoleucine, 242 mg. of leucine, 144 mg. of methionine, 5 mg. of tryptophane, and 326 mg. of valine per 100 grams on a fresh weight basis.

The total nitrogen content of mushrooms was about 0.5 percent, of which 63 percent was in the form of protein. Purified mushroom protein had a nitrogen content of 11.79 percent. It was concluded that fresh mushrooms contain approximately 2.67 percent of protein. While they are not comparable with such foods as meat and fish as a source of protein, they do compare favorably with some fresh vegetables.

Commercially canned mushrooms (18 different samples) were found to be good sources of the B-vitamins, averaging 0.249 mg. of riboflavin, 1.8 mg. of nicotinic acid, and 0.83 mg. of calcium pantothenate per 100 grams of total can content. The biotin content averaged 6.57 micrograms per 100 grams of can contents.

In the canning of mushrooms, blanching in hot water caused little or no loss of the B-vitamins, but a significant loss occurred during processing. When canned mushrooms were stored for one year, there was some loss of riboflavin but little or no loss of nicotinic acid, calcium pantothenate, and biotin. When fresh mushrooms were cooked by home canning methods, 90.4 percent of the riboflavin, 87.4 percent of the nicotinic acid, 86.4 percent of the calcium pantothenate, and 50 percent of the biotin were retained.

Glass Container Research. (W. B. Esselen, Jr., J. E. W. McConnell, J. J. Powers, A. Filios, C. Dubord, and N. Guggenberg.) Added d-iso ascorbic acid did not affect the flavor of asparagus or grape juice canned by commercial methods. The addition of 20 mg. of d-iso ascorbic acid per 100 ml. to bottled grape juice which had been fortified with 50 mg. of l-ascorbic acid per 100 ml.

completely protected the added l-ascorbic acid from oxidation. If bottled grape juice is fortified with ascorbic acid so that it is equal to citrus juice as a source of vitamin C, the ascorbic acid is well retained during storage. Added ascorbic acid is quite stable in apple juice and cranberry juice during processing.

Ascorbic acid has been shown to function as an antioxidant in processed fruits and fruit juices because increased concentrations of it shifted oxidation reactions away from flavor and color substances and more toward the ascorbic acid in accordance with the Law of Mass Action. Redox potential measurements indicate that ascorbic acids also function as antioxidants because they set up low, highly poised potentials in foods. The poising capacity of a processed food has been found to be of greater relative importance than its actual redox potential in determining resistance to oxidative deterioration.

Storage at 40°F. in the dark significantly retards the development of rancidity in corn and cottonseed oils. A good quality oil can be stored for one year at room temperature without serious deterioration if protected from the light. Amber glass containers are very effective in protecting edible oils against the effects of diffused daylight. Metal containers protect these oils against the effect of light but a slight off-flavor, due apparently to the container, develops during storage. To date no entirely satisfactory antioxidants have been found which are effective in retarding the development of rancidity in edible liquid oils. Many of those which retard rancidity impart an objectionable off-flavor to the oil. The initial quality of an oil is of major importance in governing its keeping quality.

From an investigation of bacterial load on fresh vegetables it would appear that potential home-canning spoilage bacteria such as spore-forming anaerobes and thermophiles are present in relatively small numbers except in occasional samples, and that their numbers are subject to wide variation. Washing and blanching prior to canning are an effective means of reducing the bacterial content of vegetables. The number of putrefactive anaerobes encountered was very low and may account for the fact that in some sections of the country the boiling water bath method of processing has been used successfully by many people.

In experimental packs of orange juice the addition of small amounts of d-iso ascorbic acid enhanced the retention of the fresh fruit flavor during processing and storage.

During the past two years complaints have been received from home canners that the jar rings they used imparted an off-flavor to home-canned foods. This problem has been investigated in cooperation with the War Food Administration and the jar ring industry. Two promising test methods have been developed by which it is possible to determine the tendency of jar rings, made from different types of rubber and other constituents, to impart off-flavors to foods. These methods have been of value in ascertaining the source of off-flavors in jar rings, and may also be of value in maintaining quality control in their manufacture.

Fifteen different varieties of peaches, provided by the Pomology Department, were canned according to home-canning techniques. The canned products were evaluated as to quality after storage for six months. Ideal, Valiant, and Ambergem varieties were graded as very good; Red Rose, Champion, New Jersey 116, Golden East, Golden Glow, Golden Globe, Hale Haven, Summer Crest, and Vedette as good; and New Jersey 66, Delicious, and Radiance, as fair.

Tests were also conducted to determine the effect of different processing methods on the quality of home-canned peaches. The boiling water bath method and processing at 0 to 1 pound steam pressure in a pressure canner gave the best product. Processing at 5 or 10 pounds steam pressure for a short time in a pressure canner resulted in a product inferior to that obtained by the former methods.

The color of home-canned beets was influenced by the variety of the beet used. It is recommended that, for a home-canned product of good red color, the Detroit Red or Detroit Dark Red variety be used.

In controlled processing studies with green beans those processed in a pressure canner were superior in color, flavor, and texture to similar beans processed in a boiling water bath.

Home Freezing — Fruit and Vegetable Variety Studies. (W. B. Esselen, Jr. J. J. Powers, K. Lawler, F. P. Griffiths, and J. E. W. McConnell.) Through the cooperation of the Olericulture and Pomology Departments tests were made to study the suitability of different varieties of Massachusetts-grown peaches and vegetables for home freezing. The products were frozen by accepted techniques and after storage for six months were judged for quality by a tasting panel, on a basis of flavor, texture, and color. Of 15 varieties of peaches Vedette, Valiant, Golden Globe, Red Rose, Ideal, Radiance, and New Jersey 116 were considered very good; Hale Haven, New Jersey 66, Ambergem, Summer Crest, Golden East, Champion, Golden Glow, and Delicious were considered good. On a basis of flavor, Summer Crest, Vedette, and Ideal were preferred.

Seven varieties of green peppers (King of the North, California Wonder, World Beater, Harris Early Grand, Harris Wonder, Waltham Beauty, and Charter Oak) were frozen, both raw and blanched. All varieties yielded a satisfactory frozen product.

Eight varieties of sweet corn were frozen, both on the cob and as whole-kernel corn. When frozen on the cob Seneca Dawn, Span Cross, Early Golden, and Golden Cross Bantam were very good; North Star, Narcross, Sugar and Gold, and Seneca 60 were considered good. In general the cut whole-kernel corn yielded a better product than that frozen on the cob. When cut off the cob in the whole kernel form Early Golden was considered to be excellent; Seneca Dawn, Span Cross, North Star, Golden Cross Bantam, and Narcross were graded very good; and Sugar and Gold and Seneca 60 were considered good.

Twenty different strains and varieties of carrots as represented by Morse's Bunching, Chantenay, Nantes, Long Change, Oxheart, Hutchinson, Danvers Half Long, and Imperator were all satisfactory when frozen.

Tests with summer squash indicated that this vegetable when frozen had only a fair flavor and would not be acceptable to many people.

Fishery By-Products. (F. P. Griffiths.) It was found that the common female sculpin or blow fish could be well utilized as a source of eggs for caviar. Caviar so prepared was very tasty and of excellent quality. About 10 percent of the weight of the fish is roe. The tail portion of the fish may be skinned and makes a very edible food. By utilizing both the roe and the tail, the sculpin should have commercial possibilities.

Venting Community Cannery-Type Retorts. (W. H. Fitzpatrick, J. E. W. McConnell, and W. B. Esselen, Jr.) (Cooperative project with the School Lunch and Distribution Branch of the Office of Supply (CCC), W.F.A.) The so-called No. 2 and No. 3 size retorts used in community canneries are intermediate in size between the pressure canners used in home canning and the large retorts used in commercial canneries. Studies were carried out to determine proper venting procedures for No. 2 and No. 3 retorts. Over 200 venting and heat distribution tests were made on No. 2 size self-heating and steam retorts and a No. 3 size steam retort. The effect of different retort loads of cans and jars on venting requirements was also studied. On a basis of the data obtained, recommendations for venting community cannery retorts have been made to the War Food Administration.

Red Squill Research. (L. R. Parkinson and F. P. Griffiths.) Laboratory tests have confirmed the fact that red squill (a raticide) of low toxicity may be fortified with a concentrate containing the toxic principle of red squill in order to provide a satisfactory commercial product. Such red squill preparations should prove to be very effective for rodent control.

Vitamin D Milk Investigations. (L. R. Parkinson and F. P. Griffiths.) Studies have been continued on the fortification of fluid milk with vitamin D. During the past year 173 samples have been assayed and all but five contained the designated amount of vitamin D. Data obtained during the past three years indicate that the present methods of fortification are reliable and that the producers of vitamin D milk are making every effort to provide a standardized product.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Julia O. Holmes in Charge

A study of Methods for Determination of Riboflavin. (A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes.) In a fluorophotometric assay of the riboflavin content of foods, conducted last year, it was discovered that the recommended procedures were not entirely satisfactory with highly pigmented foods such as kale and baked beans. A comparison was therefore made of the biological, microbiological, and fluorophotometric methods currently used in assays for this vitamin. Four foods were studied: beans, milk, kale, and fish. Good agreement between certain modifications of these three methods was found when applied to milk, kale, and mackerel. The microbiological method appeared to give low values for baked beans.

On the basis of the good agreement between the three types of assay procedures, it was concluded that one currently recommended step in the fluorophotometric procedure was responsible for the introduction of a marked error in assay values; namely, the manner in which the comparison was made between the fluorescence of the food extracts and the standardized solution of riboflavin. In every instance in which the fluorescence of the standard was determined apart from the food extract, erroneously low values were obtained; in those instances in which the riboflavin standard was added to the extract, values were obtained which agreed well with those obtained by the biological method and, with the exception of those for beans, with the microbiological method. The conclusion therefore has been drawn that it is imperative that the standardized solution of riboflavin be added to the food extract.

Both the fluorophotometric and the microbiological procedures contained manipulations found to be unnecessary when applied to the foods studied. The enzymatic digestion of the foods appeared to be unnecessary. In the microbiological procedure, the removal of fat from the extracts and the addition of an irradiated extract to the blank and to the standard curve did not affect the values for riboflavin. In the fluorophotometric method the use of florosil on which to absorb the riboflavin conferred no advantages. This was true also for the procedure involving the oxidation of the extracts with $KMnO_4$.

The riboflavin content of frozen baked beans, blanched kale, and steamed fish did not decrease over a six-month period.

Relationship Between Calcification of Eggshell and Carbonic Anhydrase Activity. (Marie S. Gutowska and U. C. Pozzani.) Previous study in this laboratory has shown a direct relationship between the activity of carbonic anhydrase in the shell gland of the hen and the calcification of the eggshell. The administra-

tion of sulfanilamide, a strong inhibitor of this enzyme, resulted in an inhibition of eggshell calcification. The present report presents a study of the effect of inhibitors other than sulfanilamide on the action of carbonic anhydrase on eggshell calcification; namely NaCNS, $KMnO_4$, and $MnSO_4$.

Rhode Island Reds of known laying capacity were held in confined laying batteries. The chemicals were administered either subcutaneously or orally. Meldrum and Roughton's manometric method was used for determining carbonic anhydrase activity in the blood and the shell gland. The quality of the eggshell calcification was determined by the eggshell breaking strength.

The administration of NaCNS was followed by (a) an inhibition in carbonic anhydrase activity of both blood and eggshell gland, and (b) a lowering in quality of the eggshell. These changes were similar to those observed following sulfanilamide administration. In constrast, $KMnO_4$, although a good in-vitro inhibitor of carbonic anhydrase, had little effect when administered to hens. The administration of $MnSO_4$, either orally or subcutaneously, was followed by an increase in the carbonic anhydrase activity. Finally, a direct relationship was found between carbonic anhydrase activity and well-known seasonal variations in breaking strength of the eggshell.

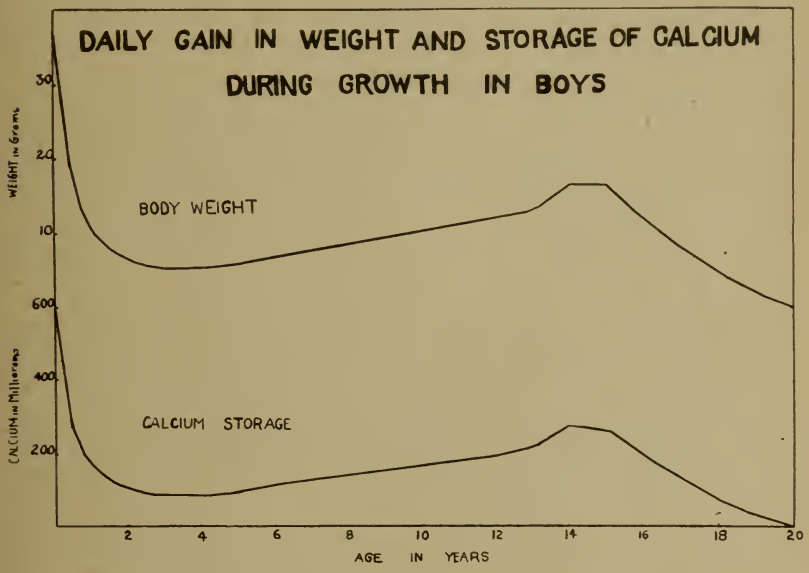
These studies provide further evidence that the formation of the eggshell is controlled by carbonic anhydrase. It is suggested that this enzyme acts as a catalyst in the shell gland for the decomposition of carbonic acid, thus allowing a greater number of carbonate ions to be released. These carbonate ions unite with calcium and are then precipitated as calcium carbonate, thus forming the eggshell.

The Requirement for Calcium During Growth. (Julia O. Holmes.) Since nutrition literature carries conflicting statements concerning the calcium requirement of children, an attempt has been made to clarify the problem. No data could be found concerning the rate at which calcium is deposited in the human body during growth. Neither could reliable information be found concerning the weight of the skeleton at different ages, an important consideration since 99 percent of the total body calcium is located in the skeleton. A search was therefore made for such information for farm and laboratory animals. Suitable data were found only for Shropshire sheep and albino rats, and included gains in weight of the body and of the skeleton, and increases in calcium content of the body at different ages. When the gains for various intervals during the growth period were expressed as percentages of the total gains made between birth and the attainment of maturity, the percentage gains in calcium were identical with the percentage gains in weight.

Since this relationship between percentage gains in calcium and in body weight was found in two strictly dissimilar types of animals, the assumption was made that the same relationship would occur in all species, including man. If this assumption is valid, it follows, for example, that the child who has accomplished 11 percent of his total growth at the end of the first year has also stored 11 percent of his total calcium. On this basis, the approximate daily storage of calcium which might be expected in boys reared under satisfactory dietary conditions was calculated and is shown in the accompanying chart, together with their daily gains in weight. The storage of calcium by girls is not significantly different during the early years of life. Their pubertal spurt of growth, however, starts earlier than in boys, i.e., at 11 or 12 years of age; and the entire process of growth is accomplished earlier than in boys, probably by the 17th year.

In converting these values for calcium storage into terms of dietary calcium, it must be recognized that infants utilize only about 35 percent of the calcium they eat; preschool children, 20 percent; and older children, 25 percent. The

following conclusions can be drawn: (a) during the first six months of life, infants need more calcium than they receive under current dietary practices; (b) the child between two and five years of age would have his calcium needs satisfied by approximately one cupful of milk in addition to an otherwise adequate diet and (c) at the peak of the pubertal spurt the child would need approximately three cupfuls of milk daily. Children previously undernourished in respect to calcium would need somewhat more calcium to bring their bones to a stage of physiological calcification.



DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

Factors Influencing the Hardiness of Evergreens. (C. J. Gilgut, Waltham.) The winter of 1944-45 was one in which there should have been little or no winter injury to ornamental woody plants. There was abundant rain in the fall, there was plenty of snow on the ground, and the temperature did not go excessively low. Yet there was as much winter injury as in the winter of 1943-44 which was preceded by an unusually dry summer and fall and during which there was almost no snow—conditions commonly stated as the cause of winter injury.

Although varying with individual plants, the injury in 1944–45, as in 1943–44, was no more extensive on plants grown with fertilizers to produce an abundant soft growth late in the season than on plants grown without fertilizer to produce a moderate amount of growth with ample opportunity for it to harden before winter.

That winter injury is not avoided when plants are grown slowly without fertilizers is shown well in a block of 128 arbor vitae (*Thuja occidentalis globosa*) set out 5 years ago. The plants received no other treatment than regular cultivation to control weeds, and the amount of current seasonal growth was moderate. They

experienced a wet previous summer and fall, a dry previous summer and fall, a winter with almost no snow, a winter with plenty of snow, mild winter temperatures, and severe cold winter temperatures. Records of the winter injury on each plant were made each spring, and it was found that there was no correlation between slow growth and winter injury. Each plant has shown injury at least once, and some have shown it after each winter. In all cases injury appeared in the spring, usually in April and two or more weeks after prolonged strong winds.

To determine whether wax sprays would prevent winter injury, several plants of Globe arbor vitae were sprayed late in the fall with Dowax 1 part to 4 parts of water. None of the plants showed winter injury, although all plants had been injured in previous winters.

Study of Herbaceous Perennial Material. (C. J. Gilgut, Waltham.) In the study of cultural requirements and winter hardiness of herbaceous perennial plants, no mulch was used during the winter. There was a good cover of snow and perhaps for this reason fewer plants were lost from winterkilling than during the previous winter when there was no snow and a hay mulch was put on after the ground froze.

Bearded iris when divided and transplanted about one month after flowering suffered less seriously from winter injury and produced better flowers the following year than when transplanted later in the season.

Professional gardeners, landscape men, nurserymen, and the general public continue to visit the gardens regularly to become better acquainted with the newer and better garden plants. Of the thirty-six new acquisitions placed in the gardens for test, many have not been introduced or disseminated to the gardening public. Numerous requests, by visitors and through the mail, for information on varieties, cultural requirements, fertilizers, and suppression of insect pests and fungous troubles were answered during the season.

DEPARTMENT OF OLERICULTURE

G. B. Snyder in Charge

Weed Control in Fields of Carrots and Parsnips. (W. H. Lachman.) It has recently been found that certain oils sprayed on fields of carrots and parsnips would destroy weeds without harming these crops. Rather extensive experiments at the college as well as many cooperative tests by vegetable growers throughout the State have indicated the value of this method for controlling weeds.

Oils which, in general, pass the specifications for "Stoddard Solvent" have given good weed control with no deleterious results. Some of the materials which pass these specifications are: Mineral Spirits, Naphtha No. 52, Sovasol No. 5, Stoddard Solvent, Sun Spirits and Varsol No. 2. Another oil, Sovasol No. 75, was found to be a good selective weed killer when mixed with two parts of white kerosene. These oils are used in industry as paint thinners, for dry-cleaning clothes, and as solvents. They seem to be highly selective for members of the Umbelliferae family such as carrots, parsnips, celery, and parsley. The leaves of celery and parsley, however, seem to be more sensitive and under some conditions are severely burned by these oils. The sprays completely destroyed young beet and turnip plants.

Best results were obtained if the oil was applied when the weeds were small and succulent. On a clear, warm day the weeds were often wilted within a half hour after spraying and were dead the next day. Almost all of the common weeds encountered have been completely controlled, with the exception of ragweed,

which is particularly resistant to the effects of the oil. Some of the carrot leaves developed a lighter color after spraying, but this disappeared in about a week with no other noticeable effect on the plants. There was no indication of a toxic residue in the soil when these oils were applied at the rate of 80 to 120 gallons per acre, which effected good weed control. The oil costs $.15 to $.20 per gallon, depending on the locality, so that on the average the material to spray an acre costs about $20.00. At the present wage scales it costs approximately $40.00 to hand weed an acre of carrots.

It is desirable to apply the oil as a flat, fan-shaped spray since this gives much more uniform distribution than a cone spray. The Skinner greenhouse irrigation nozzle ST50 was found to be well adapted to delivering the desired type spray. The oil seemed to give best results when applied at about 100 pounds pressure. Higher pressures developed a drifting mist type of spray that was objectionable.

It is suggested that this method of weed control be tried on a small scale at first much the same as with other new developments.

Other details of this method have been published in Massachusetts State College Extension Special Circular 120, and a report also appears in the Proceedings of the American Society for Horticultural Science, Vol. 45.

The Carotene Content of Carrots. (W. H. Lachman.) Ten varieties and strains of carrots were grown during 1944 and were analyzed for carotene during successive stages of maturity as well as after storage in a warm room for three weeks and in cold storage at 32°F. for five months. From the results of the analyses it was rather apparent that the carotene content of carrots increased as the root matured. Carotene appeared to be directly correlated with a deep orange coloration in both the core and cortex of the carrot. Expressed as thousands of Vitamin A Rat Units per pound, the carotene content of the mature carrots ranged from 51.5 to 98.0; from 76.0 to 156.0 after 3 weeks at room temperature; and from 56.5 to 100.0 after 5 months at 32°F. It is noteworthy that the carotene in the carrots was relatively indestructible under various storage conditions, even showing an apparent increase which was no doubt due to moisture loss through respiration and evaporation.

Two bunches of California-grown Long Imperator carrots, purchased on the open market early in April, 1945, were found to have a carotene content of 62.0 thousand Vitamin A Rat Units per pound. These were bunch carrots and rather small. A similar sample, purchased in early May, 1944, analyzed 98.0 thousand units. These carrots were a little larger, which probably accounts for the greater carotene content.

Vegetable Breeding. (W. H. Lachman.) A large number of sweet corn inbreds has been produced by inbreeding open-pollinated varieties. One of the most promising of these, Massachusetts No. 8, is being increased for production by a large seed grower in Idaho. Massachusetts 8 is an excellent inbred line. It has many of the characteristics of Purdue 39 but is about a week earlier, has a larger ear, stiffer stalk, and excellent seed quality.

Number A-13 tomato, a selection from the cross Allred by Rutgers has been sent out for trial in several states and has performed very well in Maine. It has good color and yields well over a long season, but the fruit has a tendency to be soft. This tomato has been back-crossed to Rutgers in an effort to recover more size and solidity.

A number of sweet pepper selections have been made which have excellent type and are particularly resistant to tobacco mosaic. Further testing is necessary to evaluate these selections.

Asparagus Investigations. (Robert E. Young, Waltham.) In a breeding project which has as its objective the improvement of asparagus both as to yield and uniformity, individual plant performance was recorded for 450 plants, representing five selected lines and one commercial strain. As evidence that increases in yield can be obtained by selection, the two highest producing strains in 1944, Nos. 1 and 4, each produced 1.3 pounds of asparagus per plant, compared with 0.76 pound per plant from Mary Washington grown from the best commercial seed. These averages are based on plots containing 75 to 98 plants each. The five-year average for these three plots in pounds of asparagus produced per plant is: No. 1, 1.18; No. 4, 1.22; and Mary Washington, 0.62.

There is a variation from year to year in the average number of spears the plants produced and also in the weight. This appears to be of a biennial nature, being up one year and down the next. Whether there is a correlation between the variation in yield and the weather cannot be accurately determined until the yield records for a greater number of years are available.

There is considerable variation in the production of individual plants in all of the strains. The plants were divided into four groups on the basis of the number of spears produced in 1944: A, 1 to 10 spears; B, 11 to 20; C, 21 to 30; and D, 31 and up. Strain 1 had almost equal distribution of plants in each group; Strain 4 had 9 percent in A, 38 percent in D, and the rest divided equally between B and C; while Mary Washington had 46 percent in the low-producing group A, 32 percent in B, 12 percent in C, and only 10 percent in the high-producing group D. Selection of parent plants on the basis of yield has, in this second generation, greatly reduced the number of plants which produced only a few stalks, and approximately doubled the yield.

For the second consecutive year, there was no rust. There was very little rust from 1937 through 1940, a moderate infection in 1941, and a severe outbreak of the disease in 1942, followed by these last two years when there was none. Weather appears to be the determining factor.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.) During the year breeding work has been conducted with broccoli, greenhouse cucumber, celery, rutabaga, New York type lettuce, tomato, carrot, and Butternut squash. While progress has been made in the development of strains of broccoli, carrot, and celery better adapted for local use, it is insufficient to justify detailed discussion.

Trellis Tomato. While Trellis No. 22 and Waltham Forcing tomatoes bred at the Waltham Field Station have wide usage as trellis tomatoes, both are somewhat inferior in table quality. With the desire to retain the cultural and market characteristics of Trellis No. 22 but to improve table quality, crosses were made several years ago with Marglobe, Rutgers, Michigan State Forcing, and Baltimore. Several selections from these crosses, now in the fifth and sixth generation were tested for yield and market adaptability. Earliness is one of the important characters of a good trellis tomato. Two selections, one a cross between Early Trellis and Marglobe, and the other a cross between Early Rutgers and Early Trellis, produced more early fruit than Trellis No. 22, as well as a greater total yield. Trellis No. 22 had a yield of 10.5 pounds per plant; the Marglobe cross 11.0; and the Early Rutgers cross 11.7 pounds. There was no significant difference between the three strains in percentage of No. 1 fruits or in percentage of cracked fruits. Although it has not been possible to keep all the table quality of Rutgers and Marglobe in the two selections, they are an improvement over Trellis No. 22. If the increase in yield is maintained for another year, samples of seed of these selections will be distributed to growers for further testing.

During the harvest season it was noted that one selection, a cross between Trellis No. 22 and Baltimore, did not crack. During the early part of the picking season it had only 1.8 percent cracked fruits as compared to 33 percent for Trellis No. 22. (In this case, a crack is regarded as any split in the skin regardless of size.) The crackless fruit was found to have air pockets surrounding the seed cavity which may offer some explanation as to why cracking does or does not occur.

Greenhouse Cucumber. Seed of two hybrid cucumbers that were reported last year as out-yielding their parent lines 25 percent was distributed to growers for trial, along with two of the inbred lines. Either the hybrids or the strains, or both, were tried in about twenty-five different greenhouses.

Hybrid No. 11 was considered the best by the largest number of growers. Hybrid No. 10 and strain No. 1 produced well for some. Strain No. 2 was too short to be a satisfactory greenhouse cucumber. One grower who kept very accurate records reported that hybrid No. 11 produced 18 percent more cucumbers during the month of March than his own strain.

The problem of producing hybrid cucumber seed for the growers is under consideration, and experiments are being conducted.

Samples of seed of hybrids No. 10 and 11 and strain No. 1 are available to greenhouse growers for further trial and testing.

Rutabaga or Cape Turnip. Bristol White rutabaga, bred for the growers in Bristol County, Massachusetts, has been found by growers in other sections of the country to have wide adaptation. It produced a satisfactory crop in dry weather when other varieties produced woody, inedible roots. Further testing of this variety has been delayed by a seed crop failure resulting from a mosaic disease. However, samples will be available for distribution in 1946.

There has been very little opportunity to have Waltham Yellow rutabaga tested because of the failure of the seed crop.

The characteristics of both of these varieties were given in last year's Annual Report.

New York Type Lettuce (In Cooperation with U. S. Bureau of Plant Industry). The name Waltham Imperial has been given to a selection taken from material supplied by the cooperating agency. This selection is somewhat similar to Great Lakes and was taken from the same breeding material. Two years' trials indicate that under local conditions Waltham Imperial will produce a greater percentage of marketable heads than Great Lakes. In the 1944 spring trials, this strain produced 97 percent marketable heads as compared to 81 percent for Great Lakes.

Since lettuce is so greatly influenced by weather conditions, it is necessary to make tests and comparisons for several years to determine whether the strain is sufficiently broad in its adaptability to produce marketable heads each year regardless of the weather. As soon as a supply of seed can be produced, samples will be distributed to growers for trial.

Other strains and selections were tested and some seemed to be well adapted for summer use. One strain, No. 13, produced 92 percent marketable heads as compared to 46 percent for Waltham Imperial and 45 percent for Great Lakes.

Greenhouse Lettuce. Trials of Waltham Early Forcing lettuce in growers' greenhouses indicate that it is not so good as Bel-May. Some of its characteristics were improvements but others more than offset them. Breeding work with greenhouse lettuce is being discontinued except to maintain a supply of stock seed of the Bel-May.

Butternut Squash. The Butternut squash has become popular on the Boston market during the past few years. The origin of this squash is somewhat obscure. Seed production has been in the hands of local growers. There has been a marked lack of uniformity in this squash, and an increasing desire on the part of growers for a better and more uniform strain. To determine whether any of the strains now in use are superior to others, 18 different strains were secured from both seedsmen and growers for trial. The yield varied from 269 to 562 boxes per acre, the percentage of cracked fruit from 10 to 31, and the percentage of crooked fruit from 1 to 37. Crooked fruits are very objectionable because they are difficult to pack in the bushel box which is the market package for this squash.

Almost all of the strains contained at least one good characteristic but none seemed to combine them all. Breeding work has been started to produce a true high-yielding Butternut squash.

DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The Influence of Various Clonal Rootstocks on Apple Varieties. (J. K. Shaw and L. Southwick.) The hurricane of September, 1944, caused damage to the trees on the dwarfing rootstocks. Those on Malling IV and IX suffered most. Those on Malling V and on the standard and near standard stocks showed no injury.

Some trees broke off at the point of union between stock and scion, a few broke below the union, and some were tipped, varying from little to complete prostration. The proportion of trees ruined was small, but large enough with some stock-scion combinations to make the use of them doubtful. We had considered Malling IV to be one of the best semi-dwarfing rootstocks, but this experience suggests its greatest weakness. Most varieties on this rootstock grow rapidly and bear early in life, but they have poor anchorage. Trees on Malling IX are usually poorly anchored and the stock, though large in diameter, is brittle so that the trees tip or the rootstock breaks when subjected to severe winds. It is a good rootstock for the home garden, making low-headed trees which bear at the age of two to four years. Home garden trees are usually located where they have some protection from high winds, and some support such as stakes made from used iron pipe is easily provided.

This experience should not discourage the use of semi-dwarf apple trees, but such orchards should not be planted on poor soils or on wind-swept sites. They should be headed low and pruned rather more severely than standard trees in order to keep them low headed. Perhaps they should be budded 8 or 10 inches high so that they can be planted deeper in the orchard. In this experimental orchard, all the trees were treated alike for purposes of comparison.

The crops of both 1944 and 1945 were much reduced by spring frosts. The amount of bloom is the best indication of potential early production of trees on dwarfing and semi-dwarfing rootstocks. It is evident that the usual habits of varieties appear when they are grown on these stocks but with some modification. Trees on Malling VIII and IX may be expected to bear at the age of two years for Golden Delicious, and four or five years for Northern Spy. Production of some naturally early-bearing varieties as Oldenburg and Wagener seems to be hastened less than that of Golden Delicious. Trees on the semi-dwarfing stocks seem to begin to bear from two to four years earlier, according to variety, than trees growing on seedling stocks.

Lethal Incompatibilities Between Clonal Stocks and Varieties of Apples. (J. K. Shaw and L. Southwick.) The varieties and strains growing on the clonal stocks Spy 227 are now in their third year from the bud. Only three varieties of common apples are growing normally. They are Shotwell Delicious, Paragon (Iowa strain), and strain G of McIntosh. Yates, "Paragon L", and McIntosh strain 12 are alive but making little or no new growth. Golden Delicious trees are nearly all dead, but a few have weak shoots from the base of the tree. Those now completely dead are Delicious, Starking, Richared, Stayman, Stamared, Blaxtayman, Winesap, Arkansas Black, Arkansas, Mammoth Black Twig (Iowa Strain) Turley, Blackmack, and McIntosh strains 1, 8, 39, 45, and R. The ornamental crabs, *Malus atrosanguinea*, *floribunda*, *hupehensis*, *sargenti*, *toringoides*, and Bechtel crab are all growing normally. McIntosh R, Stayman, and Winesap, which failed when budded on Spy 227, are still growing vigorously on the two clonally propagated rootstocks Spy 227-2 and Spy 227-12 which came from seedlings of Spy 227. Further studies planned to throw light on the nature of this lethal incompatibility are being carried on. A second paper reporting on this project appears in Volume 45 of the Proceedings of the American Society for Horticultural Science.

Study of the Bud Sports of the McIntosh Apple. (J. K. Shaw and L. Southwick.) None of the strains reputed to be distinctly striped have yet fruited. Several strains reputed to be uniformly red have fruited, also one random selection considered to be an ordinary McIntosh. This seems to be slightly inferior in color to the strains selected for high color. Those fruiting are growing on very dwarfing stocks while none of the striped strains are on very dwarfing stocks. Spring frosts in 1944 and 1945 have interfered with cropping in this orchard. Further observations are needed before any positive evaluation of these red strains can be made. Doubtless the distinctly striped strains should be avoided.

The orchard of seven strains on three clonal stocks, now in its fourth year of growth, shows no significant differences in vigor of these strains. The present differences in size of the trees seem to be due to environmental conditions and the size of the trees when set.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) Since there was a crop in 1944, further data were collected on two lots of seedling peaches and three were selected as worthy of further trial.

In the spring of 1945, some seedlings from the northern Caucasus region, reported to be very hardy in bud, were set in an orchard to compare their hardiness with that of Elberta and Greensboro.

Tree Characters of Fruit Varieties. (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) This project has been under way for many years and the basis for identifying practically all varieties of apple, pear, plum, and cherry, originating as seedlings, has been established. The apple variety Van Buren, believed to be a bud sport of Oldenburg, is the only variety of such origin that can be distinguished from its parent. The constant appearance of new varieties makes the continuance of this work desirable. Some progress with peaches has been made, but it is doubtful whether it is possible to distinguish some varieties in the nursery. However, most of the nursery mixtures can be detected and many thousands of misnamed peach trees have been eliminated from the trade.

The practice of examining nurseries for trueness-to-name enters its 25th year in 1945. This work is now carried on by members of the College staff under the name of the Massachusetts Trueness-to-Name Inspection Service, sponsored by the Massachusetts Fruit Growers' Association.

A bulletin on pear varieties has been published.

Nature of Winter Hardiness in the Raspberry. (J. S. Bailey, A. P. French, and R. A. Van Meter.) Five canes each of the varieties Marcy, Washington, Taylor, Milton, Chief, and Latham were brought into the greenhouse at about weekly intervals from November 7 to December 21, 1944, for forcing.

Among the canes brought in November 7, those of the varieties Marcy, Washington, and Milton started in 37 to 39 days, while some of the canes of the varieties Latham, Chief, and Taylor never did start. By November 15 all varieties could be forced to grow, but the first three varieties started more readily than the others. By December 1, all varieties except Chief started on the avearge in from 17 to 22 days. Therefore, (1) these varieties are divided into two groups, one of which can be started into growth more readily than the other; and (2) for all but Chief the rest period was over by December 1 and for Chief by December 21.

A Wheatstone bridge apparatus was set up to test the resistance of raspberry canes in the hope of finding a method to tell in the field whether canes are alive or dead. When live canes were tested and then killed by freezing in a cold room, the resistance was less after freezing. As canes dried out the resistance increased. Canes brought in from the field during the winter and tested had either a normal or a very high resistance. The latter indicates that the canes had either been killed by drying or had dried out between the time they were killed and the time the resistance tests were made.

Controlled-Atmosphere Storage of Apples. (L. Southwick and O. C. Roberts, in cooperation with the Department of Engineering.) The 300-bushel controlled-atmosphere room was filled on September 28, 1944, and opened on March 7, 1945. Instead of maintaining the levels of oxygen and carbon dioxide at 2 and 5 percent respectively, necessitating the use of a special air scrubbing apparatus, it was decided to try the English system of 10 and 11 percent, which can be maintained in a tight room by the proper use of ventilation. Actually the carbon dioxide level ranged mostly between 9 and 11 percent. The sum of the carbon dioxide and oxygen always equalled about 21 percent which is the percentage of oxygen in air. The temperature was maintained at 40°F.

The main test was with McIntosh from 25 individual trees. Check lots were stored in the usual way around 32°F. Average firmness of the flesh as measured by a pressure tester on March 6 showed no consistent differences, indicating that the levels of oxygen and carbon dioxide used were not so effective in prolonging storage life of McIntosh apples as the levels previously used; namely, 2 and 5 percent. Furthermore, scald was a real factor varying from very light to very severe, and averaging about 10 percent. Apples from some trees showed from 50 to 75 percent visible scald on removal from the controlled-atmosphere room. This was probably due to the relatively high carbon dioxide concentration. Only occasional scald was found on McIntosh in the regular storage.

Cortland apples from two orchards softened significantly less in the controlled-atmosphere room than in regular cold storage, but scald was much worse.

The possibility of positive scald control by air purification is under study.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) This experiment has now a continuous record for 24 years. Certain changes of treatment of some of the seven 10-tree plots of McIntosh apple trees have been made from time to time. In addition to the comparison between sod-nitrogen and cultivation without fertilizer, the effect of hay mulch and of the addition of phosphorus and potash to nitrogen have been studied.

The sod vs. cultivation question was soon answered. Cultivation without nitrogen does not maintain production. This conclusion has been supported by

practical experience. No successful Massachusetts fruit grower now attempts to grow apples without nitrogenous fertilizers.

The application of a hay mulch with no other fertilizer to one of the cultivation plots more than doubled the yield over a six-year period. This practice is increasing in Massachusetts orchards.

The application of nitrate of soda only to a cultivation plot quickly increased yields, but they have not been well maintained.

The answer to the question of the value of phosphorus and potash added to nitrogen is not so clear. There is some indication that when applied to grass sod, yields are maintained better. We dare not say that it has been profitable.

The problem of orchard fertilization is a complicated one and present knowledge is sadly inadequate. We can confidently recommend the use of nitrogen in practically all orchards. In general, the heavier the application (within reason), the greater the yields. But high nitrogen delays maturity, and fruit color may be poor. We can with equal confidence recommend the use of magnesium, potash, and boron when deficiency symptoms appear. But may not a lack of these and perhaps other elements interfere with maximum yields in the absence of clearly defined deficiency symptoms?

Studies of Varieties of Fruits. (J. K. Shaw and Staff.) Among the new peach varieties are a number which look promising. Since most of the peaches described below have fruited only one year, the following evaluations are tentative.

No variety earlier than **Oriole** appears worthy of consideration. Most growers do not like Oriole because of its small size and not too attractive appearance. It has been recommended chiefly because of its bud hardiness.

Fisher, which ripens with Oriole, may be a substitute although its performance in 1944 was not impressive. It is a sport of Valiant and is supposed to be like that variety in every way except ripening date. The fruit was medium to large, round, fairly attractive and yellow-fleshed, but had a tendency to cling. The flesh was a bit stringy and soft when ripe. There was a marked tendency for the fruit to soften at the tip.

While **Golden Jubilee** is an excellent peach, it softens a little too rapidly to suit most commercial growers. There are two possibilities in its season.

Raritan Rose, a cross between J. H. Hale and Cumberland from New Jersey, is a medium to large, well-colored, attractive, white-fleshed, freestone peach. The quality is good, but the flesh tends to be soft and slightly stringy and bruises easily when ripe. It is not impressive but is worth watching if one wants a white-fleshed peach in this season.

Red Haven, a cross between Halehaven and Kalhaven from Michigan, is a large, round, very highly colored, very attractive, yellow-fleshed freestone. Since only a few peaches were borne, the size was probably larger than normal. The flesh was firm and the skin thick and tough so that it should fulfill its reputation of being a good shipper. The quality, while not all that could be desired, was fair to good. The tree is said to be hardy and the fruit buds much hardier than Elberta but not so hardy as those of South Haven or Rochester. It is worthy of trial.

Between Golden Jubilee and Halehaven there are three varieties worthy of attention. **Red Rose** is a large, round, high quality, white-fleshed, freestone. It looks very promising as a white-flesh peach ripening just before Halehaven. The fruit is well covered with red and, therefore, very attractive. It softens slowly and should be a good shipper. **Fireglow,** formerly New Jersey No. 71, is a truly handsome peach of unusually high quality where it can be grown. Un-

fortunately, the fruit buds are so tender that they will not survive even an ordinary winter. It is not recommended for Massachusetts. **Golden Globe** is a large, round, very attractive, yellow-fleshed freestone of excellent quality. Unfortunately the fruit buds are rather tender to cold. It probably cannot be successfully grown in Massachusetts except in unusually favorable locations.

Sunhigh, a cross between J. H. Hale and 40 CS from New Jersey, is a large, oval, yellow-fleshed freestone. Although the flesh is a bit stringy and a little soft, the quality is good. It ripened with Halehaven in 1944. The trees are still small and the crop was very light.

Triogem, a cross between J. H. Hale and Marigold from New Jersey, is a large, yellow-fleshed freestone of very good quality. It is attractive and has firm flesh and thick, tough skin. It is reported to be a good shipper. It ripened with Halehaven in 1944. It is said to require good growing conditions and considerable thinning, to ripen slowly, and to hang to the tree well. It is well worth a trial.

Between Halehaven and Belle of Georgia, there are four varieties worth considering. **Goldeneast**, a cross between Elberta and New Jersey No. 38 (an Elberta-Greensboro cross), is a large, round, attractive, yellow-fleshed peach of high quality. It is usually a freestone, although it tends to cling slightly in some seasons. It ripens with Halehaven or a little later. However, it is another one of those peaches with fruit buds not hardy enough for best results in Masaschusetts. **Colora**, which ripens with Goldeneast and Halehaven, is a very attractive, yellow-fleshed peach of fair quality and size. It tends to soften rapidly and, therefore, is probably not a good shipping peach. Its outstanding quality for Massachusetts is fruit bud hardiness. One grower in Massachusetts had a few peaches after the winter of 1942-43, when other varieties were frozen out. In spite of its weaknesses, it seems worthy of further trial because of its apparent hardiness. **Pacemaker**, a cross between J. H. Hale and Marigold from New Jersey, ripened three days after Goldeneast in 1944. The fruit is large, round, firm, attractive, but not as highly colored as some, usually freestone with a slight tendency to cling at times. Quality is good to excellent. The trees are said to be semi-dwarf like J. H. Hale, and the flowers are self-sterile. It deserves further trial. **Summercrest**, a cross between Hale and Cumberland from New Jersey, ripened just after Pacemaker, five or six days ahead of Belle of Georgia. The fruit is large, oval, firm fleshed, and fairly attractive, although the color is not all that could be desired, especially if grown on rich soils or given much nitrogen. It is said to color up much better on thin soils or those low in nitrogen. A thick tough skin together with the firm flesh should make it a good shipper. It is worthy of trial.

Polly ripened in 1944 between Summercrest and Belle of Georgia. It is a white-fleshed freestone of very good quality with very soft flesh. It is almost a duplicate of the old Champion. Although it is supposed to be exceptionally hardy in bud, it has not been outstanding in this respect at Amherst. For anyone who wants a white-fleshed peach at this season, a few trees might be considered, but it is much too soft to ship.

White Hale, an open-pollinated seedling of J. H. Hale, is one of a growing list of patented peaches. It is a large, round, attractive, white-fleshed, freestone with considerable red around the pit. It resembles J. H. Hale considerably except in flesh color and in having self-fertile flowers. Quality is good but not best. It seems to soften a little too rapidly for a good commercial sort. Ripened with Elberta in 1944.

Sungold is a medium to large, round to oval, attractive, yellow-fleshed free stone, of high quality. The skin is thick and tough so that it should be a good shipper. It ripens with Elberta. The tree is rather small and dwarfish like Hale. It is said to be very hardy and, therefore, seems worthy of further trial.

Fertile Hale, a whole tree sport of J. H. Hale, is another patented peach. It is a large, round, yellow-fleshed, freestone ripening with Elberta and J. H. Hale. It is only fair in quality and appearance, and resembles Elberta type more than J. H. Hale. Its value is doubtful.

Afterglow, a cross between J. H. Hale and New Jersey No. 27116, which ripens a few days after Elberta, is a large, round to oval, firm, yellow-fleshed freestone, with skin medium tough and thick so that it should be a fairly good shipping peach. The flavor while not the best is better than Elberta. It is not so highly colored as some, but is fairly attractive. It deserves further trial.

Blueberry Culture. (J. S. Bailey.) Although there were no extremely low temperatures during the winter of 1944-45, what appeared to be winter injury was very severe in the spring of 1945. However, the appearance of many apothecia of the mummy berry disease indicated a very heavy infection and suggested that much of what looked like winter injury might be due to the ravages of this disease. Accordingly, an experiment to control it with fermate was started in cooperation with Dr. Sproston of the Botany Department. Although it is now evident that the first spray was not applied early enough, there was some reduction of the primary infection of twigs and blossoms. It is too early to tell how effective fermate will be in preventing fruit infection.

A scale insect, probably a *Lecanium* sp., appeared on some bushes. Application of D289 spray at the rate of 1 quart per 100 gallons on March 29, 1945, when the buds had nearly reached the delayed dormant stage, reduced the scale by at least 80 percent.

In another part of the planting, blueberry bud mite was found. DN 111 was effective in controlling the mites but caused injury to the leaves and spotting of the fruit.

Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) Because of very severe winter injury during the winter of 1943–44, the crop on the manure plots was exceedingly light. Amount of winter injury was not affected by manurial treatment. Some plants are making much poorer growth than others, but this seems to be the result of the type of soil profile. Most of the field is underlaid by a layer of compact, fine, gray sand into which the blueberry roots seldom penetrate. Where this compact layer is less than six inches from the surface, the plants do not grow well.

To test the effect of potassium on the appearance of chlorosis, a number of rooted cuttings were planted in 1-gallon crocks in the greenhouse. The soil was from a section of the field where chlorosis had appeared and was treated with varying amounts of K_2SO_4. No chlorosis has appeared, even in the untreated soil.

Preharvest Dropping of Apples. (L. Southwick.) Tests were made on Wealthy and McIntosh to determine the comparative effectiveness of sprays and dusts containing higher percentages of active chemicals than "standard." With Wealthy, there was a good correlation between spray or dust concentrations and drop control. For example, in one test, treatments and percentages of preharvest drop were as follows: Check, 36; standard spray, 18; triple concentration spray, 8; standard dust, 16; double concentration dust, 12; triple concentration dust, 4.

With McIntosh, the September 14–15 hurricane wind terminated the tests too early for best results. However, in many cases, control of drop was better with the stronger sprays and dusts. Since the wind broke many spurs, the "hormone" applications were not effective in reducing drop during the hurricane.

The data show benefits from stronger sprays and dusts, but whether the benefits would warrant the increased cost of material is not proven. In any case, with McIntosh and Wealthy, it would seem unwise to use less than standard amounts of commercial materials; in many cases, increased concentrations are justifiable on the basis of insurance alone.

A small test on Duchess showed good results with lower than standard concentrations. This variety is much more easily influenced by "hormone" drop control applications than many varieties including McIntosh.

Plans for using a promising, newly exploited chemical in drop-control tests are underway. It is very possible that more effective materials than naphthalene acetic acid will be found.

Beach Plum Culture. (J. S. Bailey.) This project was concluded and the results published in Experiment Station Bulletin 422, "The Beach Plum in Massachusetts."

Control of the Peach Tree Borer. (J. S. Bailey.) Paradichlorobenzene, ethylene dichloride, and propylene dichloride were applied to peach trees according to standard directions for each. There were so few borers even in the untreated trees, that no indication of their relative effectiveness for borer control was obtained. It is worth noting that none of these materials properly applied caused any injury to the trees.

Magnesium Deficiency in Massachusetts Apple Orchards. (L. Southwick.) The inclusion of 20 pounds of Epsom salts per 100 gallons of spray solution in 3 early-season applications was rather effective in preventing the appearance of magnesium deficiency leaf scorch in the year of application. This treatment seems especially valuable for trees which may be slow in responding to soil applications of magnesium materials. As a temporary measure for controlling scorch, it has a definite place, particularly in mature orchards.

Soil applications of Epsom salts and kieserite were beneficial in young, mulched blocks; but one application of dolomite, kieserite, or Epsom salts was rather ineffective in a seriously deficient bearing orchard under sod culture. The application of commercial magnesium oxide (92 percent MgO) appeared to result in greater increases of magnesium in apple leaves on young trees than the use of Epsom salts applied in similar amounts by weight. Results with magnesium oxide on older trees have not been obtained. Commercial dolomite (magnesium limestone) has seemed to be less beneficial than other materials, even when used in relatively large amounts.

Although some time may elapse before applications become effective, the use of magnesium lime is recommended in most orchards where magnesium deficiency symptoms have appeared. Its use in other orchards is suggested as a means of preventing the deficiency. Prevention is possible and is preferable to allowing the trouble to appear and then trying to correct it. A report of several field experiments will be published in Volume 46 of the Proceedings of the American Society for Horticultural Science.

Thinning Apples with Caustic Sprays. (J. K. Shaw.) Attempts to thin apples in 1944 by spraying with Elgetol at blooming time were partially successful. The trees receiving a second application and those receiving the stronger concentration required less thinning. The apple bloom in 1945 was light, and most

of the trees sprayed in 1944 failed to blossom at all. Two or three that had received the heavier sprays had a light bloom, but the sprays were not generally successful in causing annual cropping.

Experiments in 1945 were interfered with by the freeze of April 23. Naphthalene acetic acid sprays applied at concentrations of 10, 20, and 30 p.p.m. apparently reduced set in all cases. Effectiveness seemed to depend more on variety than on concentration. Wealthy and Baldwin were thinned less than Melba and Early McIntosh. Spur leaves seemed to show some dwarfing injury and this also seemed to depend more on variety than on concentration, Melba showing the most injury. This limited experience gives some hope that this material has value as a blossom thinning spray.

Killing Poison Ivy. (L. Southwick.) Following two yearly applications of ammonium sulfamate to poison ivy under apple trees, there is only slight indication of recovery (July 1). If the ivy makes any growth the year following treatment, experience seems to show that it will continue to grow and spread. In short, treatment is needed until there is no recovery. Probably one pound of the chemical per gallon of water is best. Other promising materials are now being developed and further experimental tests are under way.

Chemical Control of Weed Grasses. (L. Southwick.) In the effort to subdue grass growth around the bases of young apple trees in sod, an application of ammonium sulfamate was made on a quiet, hot, humid day in August 1944, to an area about 5–6 feet in diameter. One pound of chemical was used in one gallon of water and a small amount of a special wetting agent was included. A fairly drenching application was made. The grass was killed and showed very little recovery up to July 1, 1945. Apparently no injury to the trees resulted even though the spray got on the trunk bark. This method may prove to be a good substitute for cultivation or hand hoeing around young trees.

A similar test of this material in May 1945 on the sod strip along a row of blueberries resulted in severe damage to the bearing blueberry bushes. Within 2 or 3 days the foliage began to take on a reddish hue and it now appears that the bushes may be killed. Probably the shallowness of the blueberry root system was a factor. This experience shows the necessity for careful testing before toxic chemicals are used in the commercial or home fruit planting.

Further work on weed and grass control is under way with several promising materials.

DEPARTMENT OF POULTRY HUSBANDRY

F. P. Jeffrey in Charge

Broodiness in Poultry. (F. A. Hays.) The major objective is to develop a line of Rhode Island Reds that never exhibits the broody instinct. The mode of inheritance of broodiness is rather well understood, but there are several obstacles yet to be overcome. The majority of the females that carry a broody inheritance exhibit the instinct in the first laying year; yet there are some individuals that fail to display broody behavior even in two or three years of laying that will, if retained longer, become broody. Degree of broodiness is governed by inherited factors. The problem of testing for deferred broodiness and of breed-testing all males is the chief concern at present.

The generation hatched in 1941 consisted of 55 females, one of which exhibited broodiness in the first laying year. The generation hatched in 1942 (106 females) exhibited no broodiness the first year. The generation hatched in 1943, made up

of 79 females, actually disclosed four broody individuals—a result which would be expected to occur only when breeding females are not fully tested for deferred broodiness and when breeding males are inadequately progeny tested. The 1944 generation includes 67 females now being tested.

Effectiveness of Selective Breeding to Reduce Mortality. (Regional Poultry Research Laboratory and Departments of Veterinary Science and Poultry Husbandry, Massachusetts Agricultural Experiment Station cooperating.) Results of this project for eight generations hatched from 1935 to 1942 were published in Bulletin 420.

To produce the generations hatched in 1943, 1944, and 1945, the plan of breeding has been changed. A low mortality line has been reproduced from yearling males and females within the line so that inbreeding has been necessary. A high mortality line has been reproduced from young males and females within the line and inbreeding has been practiced. The sole basis of selection in both lines has been the mortality rate. Results thus far suggest that selective breeding may be effective in producing two lines that differ significantly in mortality rates to the age of 18 months.

Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl. (F. A. Hays and Ruby Sanborn.) In Bulletin 423 it was shown that at least sixteen different factors may affect egg production. These factors are in part environmental, but probably in greater part are governed by inheritance. Among the most important new characters are spring, summer, and fall intensity. Of considerable importance also are spring and summer pause duration. Special attention is now being given to the inheritance phase of spring, summer, and fall intensity.

The primary sex ratio in chickens has been studied for the first time and evidence of a 50-50 sex ratio reported.

A line of birds carrying only autosomal gene E′ for early sexual maturity has been developed. Such females attain sexual maturity at from 190 to 200 days of age. When sex-linked gene E was present with gene E′, the mean age at sexual maturity was reduced to 170-175 days. When neither gene for early sexual maturity was present, the age at sexual maturity ranged from 200 to 300 days.

A Study of Fertility Cycles in Males. (F. A. Hays.) Results reported for the hatching season of 1944 suggest that sex hormones may have some value in stimulating males that are at least 36 months old to active spermatogenesis. They had no value for younger males. This test was repeated in 1945 using a higher dosage of sex hormone and more artificial illumination. Results were entirely negative in this second test and fertility stood at the same level in hormone-treated, artifically lighted, and control pens.

A Genetic Analysis of Rhode Island Red Color. (F. A. Hays.) Colorimetric studies on feather pigment from three generations indicate that dense pigmentation in darker colored birds is due to several recessive genes. Further study is being given to this phase of the problem.

Secondary and Adult Sex Ratio in Relation to Hatchability. (F. A. Hays.) High and low hatchability lines were started in the spring of 1945. A complete record of sex is being secured on all dead embryos from the ninth day on and upon all chicks up to the adult stage of sexual maturity.

A Study of Egg Characters of the Domestic Fowl. (F. P. Jeffrey.) Nine hundred and sixteen pedigreed R. I. Red pullets from 161 dams and 22 sires have been classified as to egg weight, degree of shell color, egg shape, percentage egg shell,

condition of firm albumen, shade of shell color, and incidence of blood spots, meat spots, blemished yolk, and fishy odor. Correlation analyses will be run to determine whether any significant relationships exist between any of these ten characters. Each character will be tested for heritability on the basis of sire progenies.

Methods of Feeding. (John H. Vondell.) Eight pens of R. I. Red pullets were fed as follows: four pens were hopper fed (free choice) mash, whole corn, oats, and wheat; two pens were hopper fed mash and hand fed scratch feed; and two pens were fed complete all mash. The feeding methods were compared for the following factors: egg production, mortality, egg weight, body weight, feed consumption per bird, feed to produce a dozen eggs, protein intake, and costs and returns. The test ran from December 1 to September 1.

Average egg production varied less than 4 percent for the three methods, and egg weight less than 1 percent. Mortality averaged 19 percent for the hopper-fed pens, 17 percent for the scratch and mash, and 13 percent for the all-mash. The scratch and mash ration seemed to maintain body weight best, with the all-mash ration poorest. Feed consumption ran 71.27 pounds per bird for the all-mash, 75.81 for the hopper-fed, and 79.05 for the scratch and mash. The hopper-fed birds required 6.39 pounds of feed per dozen eggs, the all-mash 6.47 pounds, and the scratch and mash 6.61 pounds. The protein intake averaged 14.08 percent for the hopper-fed birds, 16.28 percent for the scratch and mash, and 16.68 percent for the all-mash. Net return per bird over feed cost was $2.77 for the hopper-fed, $2.58 for the scratch and mash, and $2.38 for the all-mash.

The test is being continued.

Comparison of Four Strains of Broiler Chicks. (John H. Vondell.) Four strains of commercial broiler chicks were kept under identical conditions and grown through 13 weeks. One strain proved vastly superior in growth, feed efficiency, and dressed grade. The return above feed cost for the four strains was $72.93, $86.39, $78.99, and $106.05.

Poultry Housing Projects. A. (C. I. Gunness and W. C. Sanctuary.) The non-insulated pen previously described (Bulletin 417:67) produced favorable results in terms of litter condition, ceiling condition, and general welfare of birds. This test was not complicated this past winter by water coming through foundations during heavy rains. Adequate drainage prevented the trouble.

B. (W. C. Sanctuary.) Of the two pens under comparison, one (No. 28) was especially arranged to increase housing capacity. The nests were on the rear wall, the pits (roosting quarters), water fount, and hoppers were elevated to give more floor space, and the rear ventilators were near the floor. The other pen (No. 27) had the usual placement of equipment, with floor pit and hoppers on the floor and the rear ventilators (of the same area as those in pen 28) as high as the ceiling would permit. The birds were allowed only three square feet of floor space per bird in each pen.

Both pens were equipped with the baffled window ventilators, and no change in ventilation adjustments was made for the second winter. With no addition of litter after early November, because none was to be had, little building up of litter was possible. The moisture content of the litter became as high as 41 percent, with some caking of the surface. The air was drier in these pens (75 percent humidity) than in other pens which were less crowded.

To June 9, 1945, the birds in pen 28 had laid 8 eggs more per bird than those in pen 27, and the mortality was 3 less than in pen 27. The preceding year, with no crowding, both pens laid practically the same.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1944–45 season, a record number of flocks (529) and samples (975,041) have been tested. The percentage of reactors detected among chickens was 0.12. It is encouraging to note that progress in eradication is being made, as is indicated by the fact that 93 percent of all birds tested are in 100 percent tested, non-reacting flocks.

Furthermore, there was a considerable increase in turkeys tested during the past season, due in large measure to the recent marked expansion in the turkey industry. Unfortunately, the pullorum status in turkey flocks in Massachusetts is not so encouraging as it is in chickens. However, this situation may be improved by working in closer cooperation with the flock owners and through more effective education regarding pullorum disease eradication and prevention.

It has been extremely difficult to meet the testing demand during the past year. Most of the flocks, however, were tested without serious delay. This was made possible by the willingness of the testing personnel to put forth extra effort in the collection and testing of the samples.

A detailed report of the 1944–45 testing season has been published in Control Series Bulletin 124.

2. *Diagnostic Service.* A total of 3801 specimens was received during 1944 in 716 consignments, of which 360 were delivered in person. The specimens were classified as follows:– 3221 chickens, 451 turkeys, 23 quail, 22 fish, 21 ducks, 13 rabbits, 12 bovine semen, 8 foxes, 7 swine, 6 guinea pigs, 3 each of canine feces and geese, and 1 each of the following: canary, canine, feline sputum, goat, goat feces, horse meat, ovine semen, pheasant, pigeon, porcine semen, and sheep.

Coccidiosis (121), tumors (70), infectious bronchitis (49), fowl paralysis (36), internal parasites (32), pullorum disease (31), and fowl cholera (29) were the disease disturbances encountered most frequently. The tumors were classified on the basis of gross examination as follows: 26 lymphocytoma, 14 myelocytoma, 9 hemangioma, 8 embryonal nephroma, 3 fibrosarcoma, 2 each of carcinoma and heart tumor, and 1 each of chondrosarcoma, hematoma, leiomyoma, and myxoma.

The tumors identified as hemangioma represent an interesting problem which is of consequence in some flocks. One owner reported a loss of 25 out of 200 pullets between the ages of five and eight months. Sporadic cases only are noted in most of the cases directed to our attention. Affected birds show a small raised opening in the skin which bleeds recurrently. The site of bleeding has been observed on various parts of the body, including the feet, legs, breast, and head of different birds. Afflicted birds usually die within a month from loss of blood. In some cases there is metastasis of the tumor to the liver, spleen, kidneys, and other internal organs. It is possible to salvage a bird by excising the tumor in the skin if metastasis has not occurred.

The incidence of fowl cholera was greater than in any previous year and infection was detected on 19 new premises. Fowl typhoid was observed much more frequently than in any year since 1939 and occurred in widely separated places within the State. One case of avian tuberculosis was identified. No paratyphoid infection in chickens was brought to the attention of the laboratory. There has been an increase in the incidence of avitaminosis A during the past two years and a dermatitis syndrome believed to be due to deficiency of pantothenic acid and biotin has been observed more frequently.

Additional field observations have been made on a disease disturbance in chicks caused by exposure to coal-tar creosote oil, which was reported last year. It appears probable that strong coal-tar disinfectants, so-called gas house tar, and kerosene improperly used may cause the same type of injury.

The 451 turkeys were received in 84 consignments which represents the largest number ever received at the laboratory in one year. Coccidiosis, enterohepatitis pullorum disease, and paratyphoid were the diseases encountered most frequently. An examination of the records for the past ten years reveals that diseases which were unidentified or were directed to the attention of the laboratory only infrequently at the beginning of the period are now of major importance to the turkey industry. A list of such diseases includes coccidiosis, hexamitiasis, infectious sinusitis, moniliasis, paratyphoid infection, pullorum disease, swine erysipelas, trichomoniasis, ulcerative enteritis, and so-called unknown disease (blue comb).

Two cases each of fowl cholera and fowl typhoid were identified in turkeys during the year. A considerable number of cases revealed heavy infestations in the lower digestive tract with motile protozoa which were identified as trichomonads. The observations suggest that these protozoa are pathogenic for turkeys and in a number of cases it has appeared that they were responsible for diarrhea, retarded growth, and mortality in poults. The infections with trichomonads are sometimes combined with coccidiosis and hexamitiasis, but frequently the trichomonads appear to be the principal cause of disease outbreaks. Microorganisms apparently belonging to the aerobic actinomycetes group were recovered from two outbreaks of respiratory disease in turkeys.

3. *Flock Mortality Studies.* From the Experiment Station flock hatched in the spring of 1943, 368 morbid and dead birds have been examined—227 females and 141 males. Cannibalism (56), reproductive disorders (50), tumors and leukemia (46), fowl paralysis (21), and kidney disorders (17) were the conditions most frequently encountered among the females. Cannibalism (81), bacterial and mycotic diseases, principally staphylococcosis, (17), and kidney disorders (12) accounted for 70 percent of the diagnoses among the males. The tumorous conditions in the population were identified on the basis of gross examination as 17 lymphocytoma, 8 leiomyoma, 5 each carcinoma and embryonal nephroma, 4 each myelocytoma and unidentified, 3 hemangioma, 2 leukemia, and 1 each cyst-adenoma and neurogenic sarcoma. The majority of cases identified tentatively as fowl paralysis failed to show gross lesions. Diagnoses of cannibalism and reproductive disorders among the females were most frequent during a period of six months, which began about three months after production started.

Erysipelothrix rhusiopathiae was identified in one seven-months-old male. The liver and spleen were slightly swollen and the heart muscle showed pale areas.

4. *Infectious Bronchitis* During 1944, 232 flocks representing approximately 400,000 birds were enrolled in the infectious bronchitis control program. These flocks were located in Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, and Plymouth counties. The procedure of the program was much the same as in 1943, except that the service was placed on a fee basis.

The results on the whole were satisfactory although in a few instances respiratory symptoms developed following the recovery from the infectious bronchitis inoculation. The cause of the disturbance was not definitely identified. It appeared that in some of these cases the infection was either an atypical form of infectious bronchitis or some other respiratory infection which has not been identified up to the present.

In some flocks complications resulted from the fact that birds of an undesirable age were inoculated. Also the condition of the flock and the season of the year had a definite influence on the results. The most satisfactory results are obtained when the birds are 10 – 14 weeks of age, in good health, and inoculated on range in June, July, and August when the weather is apt to be favorable.

This control program is in need of many refinements. Work is in progress to develop an immunizing procedure which will eliminate the possible hazard of dissemination.

5. *Farm Department Brucellosis Control and Eradication.* The laboratory tested 369 bovine and 33 porcine blood samples by the standard tube agglutination method during the 1944 calendar year.

WALTHAM FIELD STATION

Waltham, Massachusetts

Ray M. Koon in Charge

The members of the research staff of the Waltham Field Station are assigned to this branch by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Refer to reports of these departments for results of investigations conducted at this Station.

Soil Testing Service. Commercial vegetable growers, mushroom growers, florists, nurserymen, and vendors of loam brought in 2918 samples of soil for testing and interpretation. For home gardeners, 3291 samples were tested.

PUBLICATIONS

Bulletins

417 Annual report for the period ending June 30, 1944. 78 pp. August 1944.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

418 The propagation and identification of clonal rootstocks for the apple. By J. K. Shaw. 23 pp. illus. August 1944.

There is a demand, far exceeding the supply, for clonal rootstocks for growing dwarf and semi-dwarf apple trees. This bulletin tells how they are grown and how the different kinds may be identified, thus helping to keep these rootstocks true to name.

419 Trellis tomatoes. By Robert E. Young. 19 pp. illus. November 1944.

The tomato is one of the most important vegetable crops in Massachusetts, and the details of its culture are of significant economic interest. This deals with the operation of a practice which has been growing in favor.

420 Mortality studies in Rhode Island Reds. By F. A. Hays. 20 pp. illus. November 1944.

Mortality from all causes is one of the most important problems of poultrymen. This report is intended to add something to the very limited information on the role of breeding in reducing mortality.

421 The identification of pear varieties from non-bearing trees. By Lawrence Southwick, A. P. French, and O. C. Roberts. 51 pp. illus. November 1944.

The identification of varieties before fruit trees leave the nursery is important if disappointments in the orchard are to be avoided. This bulletin considers the characteristics by which nursery pear trees may be identified and records descriptions of 47 varieties and photographs of 41 varieties.

422 The beach plum in Massachusetts. By John S. Bailey. 16 pp. illus. December 1944.

The beach plum industry on Cape Cod and the islands of Nantucket and Martha's Vineyard has developed to the point where there is a demand for improved plums and better methods for growing them. This bulletin reports work done to satisfy this demand.

423 Factors affecting annual egg production. By F. A. Hays. 12 pp. December 1944.

Modern methods of poultry breeding are based on specific characters that affect egg production. This study was undertaken for the purpose of developing more accurate methods of selecting birds for breeding purposes where the primary object is increased egg production.

424 The culture of set onions in the Connecticut Valley. By W. G. Colby, C. J. Gilgut, and H. M. Yegian. 16 pp. illus. April 1945.

The weather conditions peculiar to the Connecticut Valley and cultural practices influenced thereby have a definite effect on the yield, appearance, and keeping quality of onions. These practices and their influence are discussed here.

425 Grass silage. By J. G. Archibald and C. H. Parsons. 11 pp. illus. April 1945.

The storing of grass and legume crops as silage has become an accepted practice. This bulletin, a revision of an earlier issue, reports the most recent findings on the subject.

426 Botulism and home canning. By William B. Esselen, Jr. 28 pp. April 1945.

In order to answer some of the many questions which have been raised concerning botulism and home-canned foods, a summary of available information is presented.

427 Carnation wilt diseases and their control. By E. F. Guba. 64 pp. illus. June 1945.

Wilt diseases cause serious losses in greenhouse carnation culture in Massachusetts. This bulletin is intended to help the carnation grower understand these diseases and to acquaint him with proven control measures.

Control Bulletins

120 Twenty-fourth annual report of pullorum disease eradication in Massachusetts. By the Poultry Disease Control Laboratory. 12 pp. July 1944.

121 Inspection of commercial feedstuffs. By Feed Control Service Staff. 28 pp. September 1944.

122 Inspection of commercial fertilizers and agricultural lime products. By Fertilizer Control Service Staff. 28 pp. September 1944.

123 Seed inspection. By F. A. McLaughlin. 41 pp. December 1944.

Meteorological Bulletins

661-672, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

Reports of Investigations in Journals

NUMBERED CONTRIBUTIONS

497 Performance studies on home dehydrators. By W. B. Esselen, Jr., S. G. Davis, and M. A. Ewing. Food Res. 9 (5):341-347. 1944.

501 Corn distillers' by-products in poultry rations. I. Chick rations. By Walter L. Nelson, F. E. Volz, Raymond T. Parkhurst, and Leonard R. Parkinson. Poultry Sci. 23 (4):278-286. 1944.

507 Ratio of soluble sugars, pectic materials, and hemicelluloses to nitrogen-free extract of some common vegetables. By Emmett Bennett. Food Res. 9 (6):462-464. 1944.

508 The significance of inherited characters affecting egg production. By F. A. Hays. Poultry Sci. 23 (4):310-313. 1944.

509 Influence of calcium and magnesium upon composition of Boston head lettuce. By Arthur D. Holmes and Leo V. Crowley. Food Res. 9(5):418-426. 1944.

510 The value of starfish meal in the poultry starting ration. By Roy E. Morse, Francis P. Griffiths, and Raymond T. Parkhurst. Poultry Sci. 23 (5): 408-412. 1944.

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513 The ratio of ascorbic, nicotinic, and pantothenic acids, riboflavin and thiamin in late summer milk. By Arthur D. Holmes, Carleton P. Jones, Anne W. Wertz, Katherine Esselen and Beula V. McKey. Jour. Dairy Sci. 27 (10):849-855. 1944.

514 The determination of tannic substances in commercial cocoa powders. By W. S. Mueller and J. W. Kuzmeski. Jour. Dairy Sci. 27 (11):897-901. 1944.

515 The effect of institutional cooking methods on the vitamin content of foods. I. The thiamine content of potatoes. By Anne W. Wertz and C. Edith Weir. Jour. Nutr. 28 (4):255-261. 1944.

516 Retention of vitamin C in foods by the use of natural gas atmosphere in dehydration. By H. L. Titus, Owen J. Brown, Jr., John Wertheim, Laurel M. Skofield, Roy E. Morse and Francis P. Griffiths. Chemical Products, November-December, 1944.

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520 Corn distillers' by-products in poultry rations. II. Laying and breeding rations. By Raymond T. Parkhurst, Carl R. Fellers and John W. Kuzmeski Poultry Sci. 24 (1):8-19. 1945.

522 Sulfur compounds as disinfecting agents for dairy equipment. By W. S. Mueller, Emmett Bennett, and James E. Fuller. Jour. Dairy Sci. 27 (12): 1007-1009. 1944.

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526 The serial passage of an avian lymphoid tumor of the chicken. By Carl Olson, Jr. Cancer Res. 4 (11):707. 1944.

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529 The fractionation of phosphorus compounds in certain vegetables. By Emmett Bennett. Jour. Nutr. 28 (4):269-271. 1944.

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II. Thiamine, nicotinic acid, and panthothenic acid content of beans. By A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes Mass. Agr. Expt. Sta. Prog. Note 2, 3 pp. 1944.

III. Thiamine, riboflavin, nicotinic acid, and pantothenic acid content of fish. By A. W. Wertz, B. V. McKey, K. O. Esselen, and J. O. Holmes. Mass. Agr. Expt. Sta. Prog. Note 3, 4 pp. 1944.

Extension Publications

The following Extension Leaflets and Circulars were prepared wholly or in part by members of the Experiment Station staff:

Mexican bean beetle. By A. I. Bourne. Mass. State Col. Ext. Spec. Cir. 15 (mimeographed). Revised, 1944.

Apple maggot. By A. I. Bourne. Mass. State Col. Ext. Spec. Cir. 9 (mimeographed). Revised, 1944.

Control of weeds in carrot and parsnip fields with oil spray. By W. H. Lachman. Mass. State Col. Ext. Spec. Cir. 120. 1945.

Control of cutworms. By A. I. Bourne. Mass. State Col. Ext. Leaflet 70. Revised, 1944.

Apple Pests. By A. I. Bourne, O. C. Boyd, O. C. Roberts, and W. D. Whitcomb. Mass. State Col. Ext. Leaflet 189. Revised, 1944.

Pest control in the home garden. By A. I. Bourne and O. C. Boyd. Mass. State Col. Ext. Leaflet 171. Revised, 1944.